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MONTANA
1983 NETWORK REVIEW

by

Robert Raisch

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DEPARTMENT OF HEALTH AND ENVIRONMENTAL SCIENCES

TED SCHWINDEN, GOVERNOR

COGSWELL BUILDING

STATE OF MONTANA

HELENA, MONTANA 59620

MEMORANDUM

TO: Recipients of Montana 1983 Network Review

FROM: Bob Raisch

SUBJECT: Network Review Errata

A few minor errors were discovered in the 1983 Network Review and are as follows:

1. Page ii - add the following to the list of tables:

39. Montana and National Air Quality Standards 187
40. Relationship between Siting Objectives and Data Use 188

2. Page 87, Paragraph 2, sentence 2 should read:

"that all three sites are being influenced"

3. Page 185 - Page 185 is a list of TSP SLAMS sites and should be located between pages 181 and 182. Page 186 should directly follow page 184.

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1983 NETWORK REVIEW

INTRODUCTION

The U.S. Environmental Protection Agency (EPA) requires the Montana Department of Health and Environmental Sciences, Air Quality Bureau (AQB) to conduct an annual review of the state's ambient air monitoring network. This report is the fifth in the series. EPA's requirements, as set forth in 40 CFR 58.20, are (1) to determine if the system meets the monitoring objectives defined in Appendix B of 40 CFR 58.20, and (2) to identify needed modifications of the network, such as termination or relocation of unnecessary stations or establishment of new stations that may be necessary. The Bureau, in accordance with 40 CFR 58.25 is required to develop and implement an annual schedule to modify the network in order to eliminate any unnecessary stations or to correct any inadequacies indicated by the results of the annual review. The Bureau must consult with the Regional Administrator of the EPA during the development of the schedule to modify the monitoring program. The final schedule and modifications are subject to the approval of the Regional Administrator.

In order to conduct this review, the monitoring objective and spatial scale of representativeness of each station, existing or proposed, are first examined to determine whether they represent the area's air quality situation. Background information, such as maps, climatological summaries, emission inventories, traffic counts, and modeling results, are gathered and reviewed. The opinions of the Bureau staff, the personnel of three county air pollution agencies as well as several other county health agencies, and staff members of the Helena EPA office also are solicited.

In the 1979 Network Review, the AQB designated each monitoring site in the State as either National Air Monitoring Stations (NAMS), State and Local Air Monitoring Stations (SLAMS), or Special Purpose Monitoring Stations (SPM). The NAMS/SLAMS network is designed to meet four basic monitoring objectives: (1) to determine the highest concentrations expected to occur in the area covered by the network (concentration); (2) to determine representative concentrations in areas of high population density (population); (3) to determine the impact on ambient pollution levels of significant sources or source categories (source); and (4) to determine general background concentration levels (background). Each station in the NAMS/SLAMS network also is sited so that the air sampled is representative of certain spatial scales, which are defined as follows:

Microscale: defines the concentrations in air volumes associated with area dimensions ranging from several meters up to about 100 meters.

Middle Scale: defines the concentration typical of areas up to several city blocks in size with dimensions ranging from about 100 meters to 0.5 kilometers.

Neighborhood Scale: defines concentrations within some extended area of the city that has relatively uniform land use with dimensions in the 0.5 to 4.0 kilometers range.

Urban Scale: defines the overall city-wide conditions with dimensions on the order of four to 50 kilometers. This scale usually would require more than one site for definition.

Regional Scale: usually defines a rural area of reasonably homogeneous geography and extends from tens to hundreds of kilometers.

National and Global Scales: these measurement scales represent concentrations characterizing the nation and the globe as a whole.

In order to site a monitoring station properly, both the monitoring objective and the spatial scale of representativeness must be determined. Appropriate siting scales for the various monitoring objectives are listed in Table 1.

TABLE 1

MONITORING OBJECTIVES AND APPROPRIATE SITING SCALES

Monitoring Objective	Siting Scales
Highest concentration	Micro, middle, neighborhood (sometimes urban)
Population	Neighborhood, urban
Source impact	Micro, middle, neighborhood
Background	Neighborhood, regional

The goal in siting stations is to match correctly the spatial scale represented by the sample of monitored air with the spatial scale most appropriate for each station's monitoring objective. During the process of the first network review in 1979, existing stations were evaluated for their monitoring objective and siting scale and, if necessary, the stations were modified. New stations established since then have been sited in accordance with the monitoring objective and siting scale determined in advance.

The AQB developed this comprehensive network review to serve as a basis for a less intensive supplement to be developed in 1984. The Bureau intends to perform a comprehensive review every two years.

Over the last two years the Montana AQB has experienced a series of budget cuts which have made it impossible to carry out many of the objectives listed

in the 1981 and 1982 Network Review. It is anticipated that additional budget restrictions during 1983 and 1984 will not only preclude the accomplishment of these objectives but will actually result in reduction of the existing monitoring network.

TOTAL SUSPENDED PARTICULATES (TSP)

TSP is the most ubiquitous pollutant in Montana, affecting the entire state. Major sources of particulates include: industrial activity, coal mines, unpaved roads, agricultural activity and residential wood burning. Table 2 lists estimated total particulate emissions by county, as determined by PEDCo ENVIRONMENTAL, INC. Table 3 lists Montana's largest point sources of particulate emissions. The highest particulate concentrations in Montana are found in urban areas such as Billings, Butte, Kalispell, and Missoula. Particularly in the western valleys, winter inversions allow particulate levels to increase and to remain high for days or weeks at a time. Some rural areas also show high particulate levels due to agricultural activities, residential wood burning, unpaved roads, coal mines, and other industrial sources.

TABLE 2

1974 PARTICULATE EMISSION RATES BY COUNTY

County	Tons/Year
Flathead	83,687
Gallatin	81,132
Lewis and Clark	66,076
Missoula	54,345
Yellowstone	53,695
Ravalli	53,683
Cascade	51,529
Lake	48,455
Roosevelt	44,290
Fergus	42,225
Lincoln	36,480
Big Horn	35,092
Valley	34,956
Carbon	34,880
Powell	34,616

TABLE 3

POINT SOURCE PARTICULATE EMISSION ESTIMATES FOR 1981/1982

Source	Part. Tons/Yr	County	City
Exxon Co. USA	1466	Yellowstone	Billings
Continental Oil Co.	1320	Yellowstone	Billings
Montana Power Co (Corette)	1094	Yellowstone	Billings
East Decker Coal	*1008	Bighorn	Decker
Westmoreland Resources	* 761	Bighorn	Hardin
Cenex	746	Yellowstone	Laurel
West Decker Coal	* 718	Bighorn	Decker
Spring Creek Coal	* 554	Bighorn	Decker
Great Western Sugar	243	Yellowstone	Billings
Bighorn Calcium	* 240	Bighorn	Warren
Kaiser Cement	*1977	Jefferson	Montana City
Anaconda Co. Butte Operation**	*1657	Silver Bow	Butte
ASARCO smelter	717	Lewis&Clark	East Helena
Ideal Basic Industries	* 418	Gallatin	Trident
Stauffer Chemical Co.	410	Silver Bow	Ramsay
Pfizer Talc	175	Beaverhead	Dillon
Cyprus Industrial Minerals	115	Gallatin	Three Forks
Louisiana Pacific Corp.	58	Powell	Deer Lodge
Western Energy	*2862	Rosebud	Colstrip
Montana Power Co. 1 and 2	989	Rosebud	Colstrip
Peabody Coal	* 500	Rosebud	Colstrip
Montana Dakota Utlities	447	Richland	Sidney
Knife River Coal	* 150	Richland	Savage
Northern Cheyenne Forest Prod.	* 126	Rosebud	Ashland
Holly Sugar	86	Richland	Sidney
St. Regis Paper Co.	824	Lincoln	Libby
Missoula White Pine & Sash	* 571	Missoula	Missoula
Champion Int. Packaging	480	Missoula	Frenchtown
Champion International	388	Missoula	Bonner
Louisiana Pacific Particleboard	374	Missoula	Missoula
Plum Creek Lumber	* 238	Lake	Pablo
Flathead Lumber	225	Lake	Polson
Plum Creek Lumber	204	Flathead	Columbia Falls
Plum Creek Lumber	189	Flathead	Kalispell
Flodin Lumber	* 180	Sanders	Thompson Falls
W. I. Forest Prod. Inc.	* 122	Sanders	Thompson Falls
American Timber	* 113	Flathead	Olney
Stoltze Land & Lumber	* 97	Flathead	Columbia Falls
Louisiana Pacific	* 93	Sanders	Trout Creek
Champion Int. Orange Street	78	Missoula	Missoula
Ksanka Lumber	* 67	Lincoln	Fortine
Anaconda Aluminum	55	Flathead	Columbia Falls

*Fugitive emissions associated with mining and vehicle traffic are included.
**The Anaconda Company Butte Operation ceased operation in July of 1983.

All of Montana's TSP monitors are sited according to the neighborhood, urban or regional scale (see Table 38). Selection of the appropriate siting scale is dependent on the station's monitoring objective. The monitoring objective for most stations is "population". In most cases, these "population" stations are sited according to the "neighborhood" scale, which corresponds to areas with dimensions from 0.5 to 4.0 kilometers.

For those stations designed to determine the impact of particulate sources on ambient particulate concentrations, the monitoring objective is "source". Most of the particulate monitoring around air pollution sources is conducted by the companies responsible for the emissions. The Bureau receives data from company sites and conducts periodic audits of the sites and data. All "source" stations are sited according to the "neighborhood" scale except for the Scobey Border site, which is sited according to the "regional" scale.

Several stations in urban areas are designed to monitor areas of highest concentration, and are sited according to the "neighborhood" scale.

"Background" stations are chosen to determine concentrations of particulates in areas remote from man-made sources. The Bureau considers that a minimum of two background stations are required in Montana, one in the eastern part of the state to characterize background concentrations in the plains, and another in a western valley for the mountainous portion of the state. Ovando, in Powell County, serves as the western Montana background station while the newly established Billing Ranch site east of Jordan comprises the eastern Montana station. The AQB took over the operation of the Jordan site from the Federal Bureau of Land Management in July of 1982. The site replaces the Lindsay site, which was destroyed by wind in February of 1982. Both background sites are sited according to the "regional" scale.

Appendix A of 40 CFR58 requires that at least two stations in the network be selected for duplicate sampling and that two samplers be co-located at these sites. Sites with the highest expected geometric mean concentrations must be chosen. Table 4 lists stations where the Bureau and the county agencies have co-located samplers.

TABLE 4

CO-LOCATED HIGH VOLUME SAMPLERS

City	Site
Billings	Taft School (NAMS)
Billings	City Hall (SLAMS)
Great Falls	Downtown (NAMS)
Butte	Greeley School (SLAMS)
Missoula	Rose Park (SLAMS)
Missoula	HW#1 (SPM)
East Helena	Hadfield (SLAMS)

Montana's network of NAMS stations for TSP consists of two stations selected from the SLAMS network. NAMS are required in urban areas larger than 50,000 population. In Montana only Great Falls and Billings have Standard Metropolitan Statistical Areas with populations in excess of 50,000. The TSP NAMS criteria are given in Table 5. Based on these criteria, both Billings and Great Falls fall into the "medium" concentration range and thus require one to two NAMS stations each. The Bureau has established a NAMS station at Taft School in Billings and the Cascade County Air Pollution Control Agency has established one at the public library in downtown Great Falls. The monitoring objectives of both these stations are "highest concentration" and "population", and both are sited according to the "neighborhood" scale of representativeness.

TABLE 5

TSP NATIONAL AIR MONITORING STATION CRITERIA*

Population Category		Concentration High	Medium	Low
High population	over 500,000	6-8	4-6	0-2
Medium population	100,000-500,000	4-6	2-4	0-2
Low Population	50,000-100,000	2-4	1-2	0

*Approximate number of stations per area

High concentration - exceeding level of the primary NAAQS by 20 percent or more.
Medium concentration - exceeding secondary NAAQS
Low concentration - less than secondary NAAQS

The AQB performed a statistical analysis for several TSP monitoring sites in Billings, Bozeman, Butte, East Helena, Great Falls, Helena and Missoula. This analysis was conducted to determine whether any duplication of air monitoring stations exists, which in turn could lead to the elimination of duplicate sites.

In order to perform the analysis, a data file was created for stations from each of the seven cities of interest:

Billings: City Hall, Grand Avenue School, Lockwood School, KGHL, and Taft School;

Bozeman: East Main, Whittier School, Traphagen Hall;

Butte: Hebgen Park, Greeley School, Dr. Canty's Office and Walkerville-Blaine School;

East Helena: Dartman, Hastie Residence, Hadfield and South;

Great Falls: Lincoln School, Riverview School, Black Eagle, Downtown, Kiwanis Park and Fire Station;

Helena: Capitol Courts, Cogwell Building, and Super Save;

Missoula: Courthouse Roof, Rose Park, Boyd Park and Northside.

For each city, only 1982 data was used. A similar analysis described in the 1981 Network Review was also reconsidered. A computer program was developed by the AQB which allows data to be directly transferred from AQDHS (Air Quality Data Handling System) to an SPSS file (Statistical Package for the Social Sciences). Table 6 describes the SPSS statistical procedures and the options utilized. The analyses were performed on the Montana IBM 3033N computer.

It should be noted that the recommendations for maintaining or terminating a station cannot be made solely as a result of this statistical analysis, but must take into account such factors as future growth in the area of the sampling site, the pollutant concentrations at the site (especially if they equal or exceed the standards), and funding. Table 34 prioritizes the proposed network modifications, so that fiscal restraints can be considered during the implementation phase.

TABLE 6

SUMMARY STATISTICS PERFORMED
ON 1982 TOTAL SUSPENDED
PARTICULATE DATA

PROCEDURE	OPTION		SPECIFIC STATISTIC
A. Condescriptive	1. Default option	a. All missing values will be excluded from the computation	Mean, variance, range, standard error, kurtosis, minimum, standard deviation skewness and maximum
B. Scattergram	1. Default option	a. Pairwise deletion of missing values if a case has one or more missing variables. b. Rectangular plot grid lines are printed. c. A one-tailed test of significance is made.	Correlation (R), R squared, significance, standard error of estimation, intercept, slope, plotted values, excluded values, missing values, and scattergram.
	2. Option #7	a. Automatic scaling: this option produces interger plot labels.	
C. T-Test	1. Paired samples	a. The t-test was performed on paired data	Means, standard deviations, and standard errors, for both data sets. Means, standard deviations and standard errors for the differences, correlation coefficient, 2 tailed probability of correlation, T value, degrees of freedom, and 2 tail probability of the t test.
D. Pearson Correlation	1. Default option	a. Pairwise deletion of missing values if a case has one or more missing values. b. One tailed test of significance.	Statistic #1 - correlation coefficient matrix, number of pairs, one tailed test of significance.

Northwest Montana

Northwest Montana includes Lincoln, Mineral, and Sanders Counties. This part of Montana is very mountainous and heavily forested. The valleys of northwestern Montana probably have the poorest atmosphere dispersion conditions of anywhere in the state. In light of this fact, the AQB is expanding the ambient monitoring program in this area.

Libby

1. Libby is a small town of 3300 people lying along the Kootenai River in extreme northwestern Montana. The Kootenai Valley runs approximately east and west in the vicinity of Libby with lesser valleys extending north and south along Pipe Creek and Libby Creek.

Libby probably has the worst ventilation of any community in Montana. Wintertime winds are almost always calm or very light. During the fall months of 1981 and 1982 the U.S. Forest Service tracked pilot balloons using an AQB theodolite and supplies. The balloon observations are performed during the fall as part of the Montana Smoke Management Plan to determine surface and upper level winds for dispersion forecasting. Table 7 summarizes the results from these observations.

TABLE 7

SURFACE AND UPPER AIR WIND SPEED
FOR SEPTEMBER, OCTOBER, AND NOVEMBER
OF 1981 AND 1982 AT LIBBY, MONTANA[1]

	Surface	100 ft	200 ft	300 ft	500 ft	750 ft	1000 ft	1500 ft	2000 ft
1981[3]	0.4(15)[2]	0.9(15)	1.0(15)	1.3(14)	2.4(14)	2.6(14)	2.9(14)	5.0(12)	4.3(9)
1982[4]	0.8(26)	1.1(26)	1.6(26)	1.7(26)	1.4(26)	1.9(26)	2.6(26)	4.3(25)	5.1(24)

(1) Data does not include days when rain, snow or fog was present
(2) Wind speed in meters per second and number of observations
(3) The 1981 observations were generally performed one-half hour after sunrise
(4) The 1982 observations were performed at noon

Most of the 1981 observations were made one-half hour after sunrise, while the 1982 observations were performed at noon. This change was made due to the high frequency of morning fog in Libby. It should be noted that this data is probably biased toward higher wind speeds because of missed data from foggy days when winds are most likely calm.

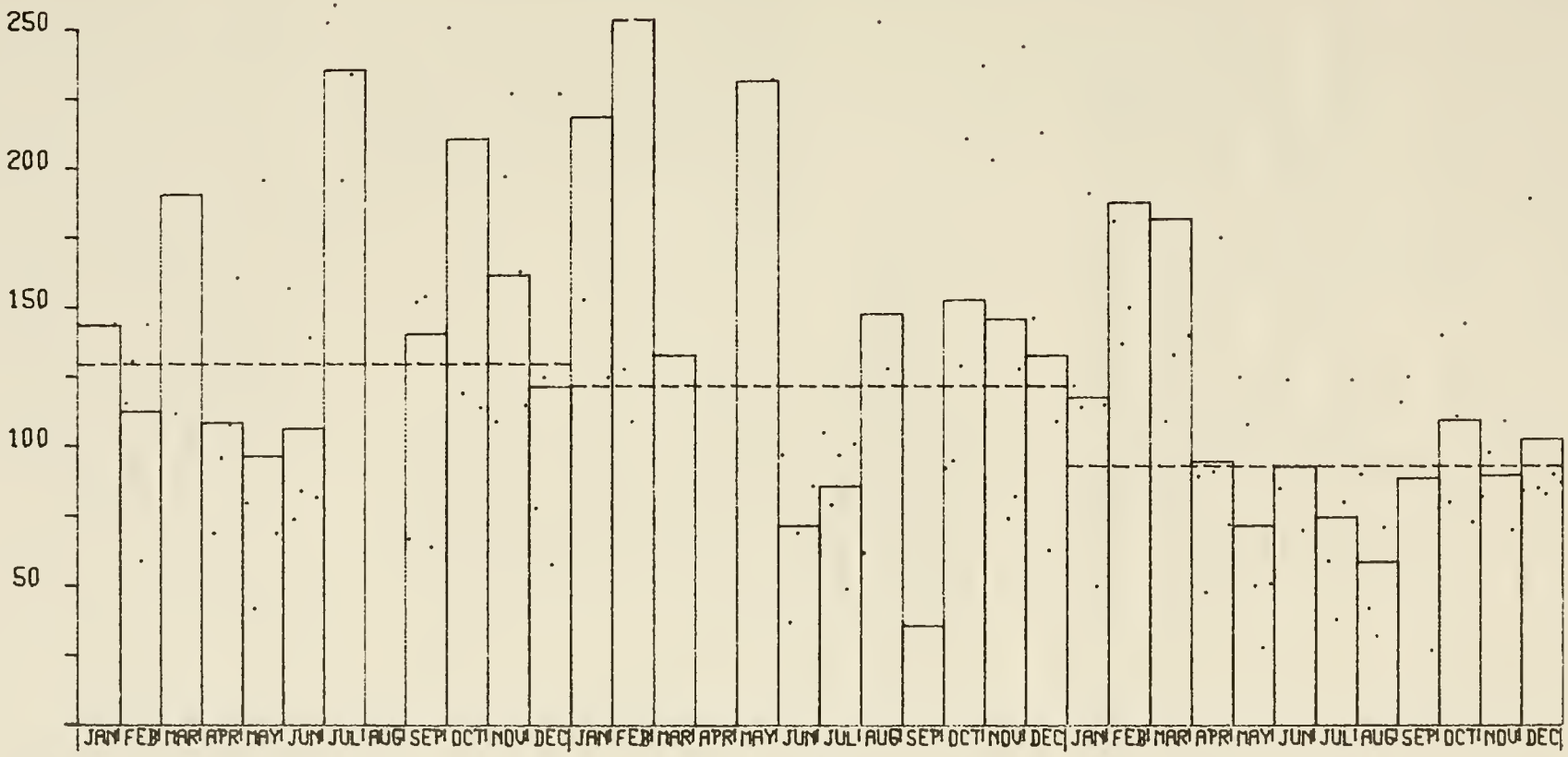
2. The Brown Residence site is located in a residential area one-half block off U. S. Highway 2 and across the highway from the St. Regis Company sawmill and plywood plant.

3. TSP levels have been monitored at the Brown residence in Libby since 1977. The geometric mean increased from 105 ug/m^3 in 1977 to 146 ug/m^3 in 1979. Since 1979 the geometric mean has shown a steady decline (see Figure 1) to a 1982 level of 92 ug/m^3. However, 92 ug/m^3 is still the highest geometric mean recorded by the AQB during 1982. The reductions during 1981 and 1982 coincide with a similar statewide trend and may be at least partially caused by improved dispersion conditions and reduced economic activity due to the recession.

4. Particulate concentrations at the Brown residence exceed both Montana and federal primary standards for annual average and 24-hour average. The primary TSP standards have been consistently exceeded at this site ever since it was established. Table 24 summarizes the TSP data for the Brown Residence site.

5. In accordance with the 1982 Network Review, the Bureau established a second high volume sampler site on the roof of the Lincoln County Courthouse in downtown Libby. The site commenced operation in January of 1983 and the limited data available indicates that concentrations in the downtown area are also elevated.

Figure 1



NUM OBS	1	4	2	4	4	5	4		5	5	5	4	3	4	1		1	4	5	3	1	5	5	4	5	4	4	5	5	3	4	4	3	5	4	6
MO.AVG	144	113	191	109	97	107	236		141	211	162	122	219	254	133		232	72	86	148	36	153	146	133	118	188	182	95	72	93	75	59	89	110	90	103
GED.AVG	130												122												93											

PLOT. . . . . CONCENTRATION VERSUS TIME
METHOD . . . . . HI VOL
UNITS . . . . . MICROGRAMS/CUBIC METER
STANDARDS . . . (FEDERAL) ANNUAL - 75 UG/CU.M

PARAMETER . . TOTAL SUSPENDED PARTICULATES
AREA. . . . . 0900, LINCOLN CO
SITE. . . . . 010, BROWN RESIDENCE
CITY. . . . . LIBBY

MONTANA STATE AIR QUALITY BUREAU

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6. TSP concentrations in Libby are generally higher during the fall and winter months than during the spring and summer. Figure 2 displays the monthly trends for 1982, while Table 8 shows a similar pattern based on an average for the years 1980 through 1982.

The AQB suspects that the high readings in the fall are caused by a combination of fugitive dust sources, including local streets, U.S. Highway 2, and the St. Regis Paper Company parking lot and log decks as well as forestry prescribed burning and residential wood burning. In the winter, residential wood burning is most likely the largest contributor.

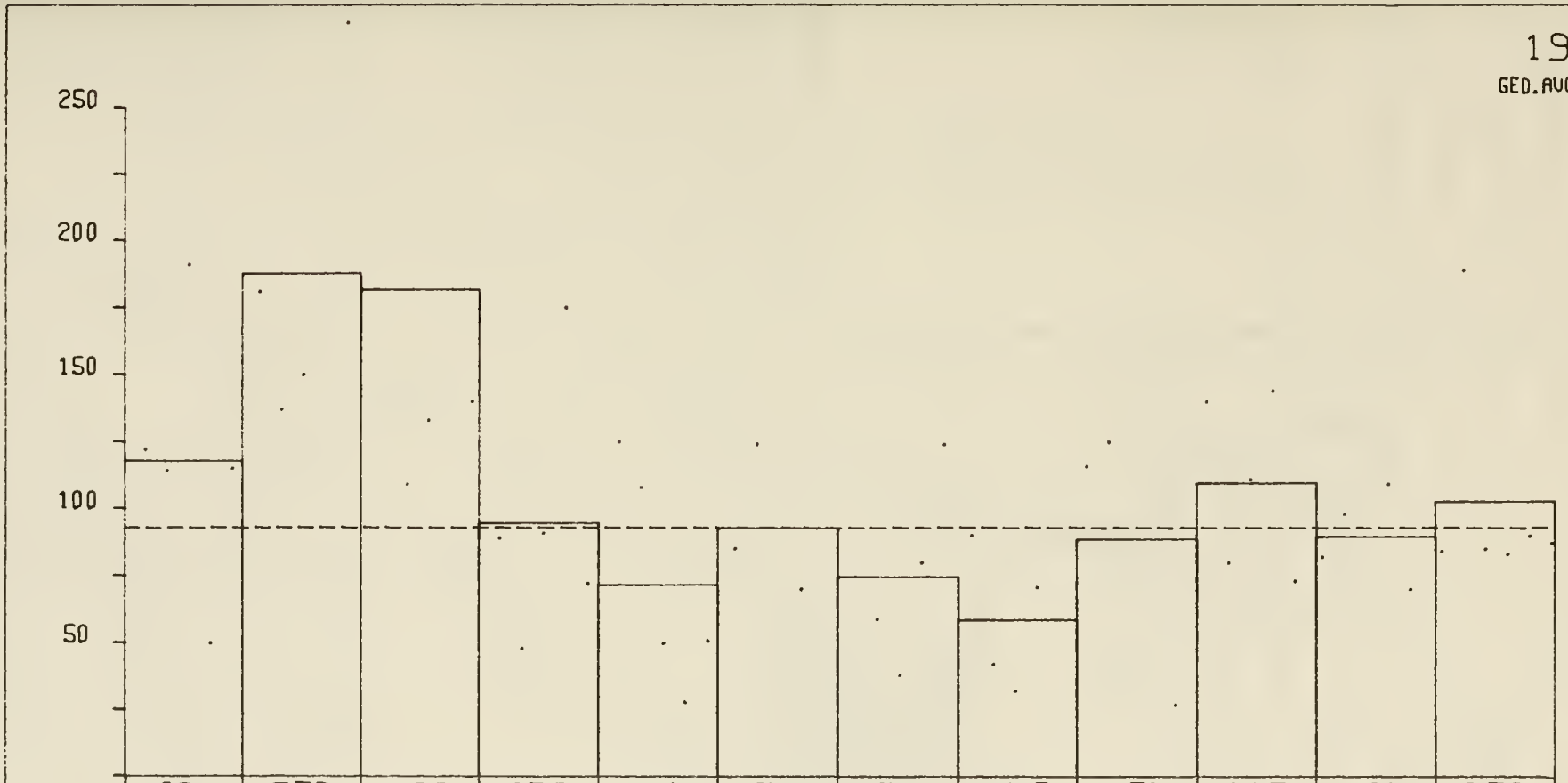
TABLE 8

AVERAGE MONTHLY TSP CONCENTRATIONS
FOR THE BROWN RESIDENCE
1980 THROUGH 1982

Month	No. of Samples	Arithmetic Average
Jan	9	154
Feb	12	185
Mar	7	178
Apr	9	101
May	10	98
Jun	12	92
Jul	13	129
Aug	7	97
Sep	9	112
Oct	15	158
Nov	14	138
Dec	16	117

7. In light of the high readings, the AQB intends to continue to operate both Libby TSP sites. In addition, the Bureau intends to install two new monitoring sites, one equipped with a nephelometer and located across the river and the other equipped with a carbon monoxide analyzer, high volume sampler and some form of fine particulate monitor. The

Figure 2



	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
NUM-OBS	5	4	4	5	5	3	4	4	3	5	4	6
1-HIGH	191	282	346	175	125	124	124	90	125	144	109	189
2-HIGH	122	181	140	91	108	85	80	71	116	140	98	90
MO.AVG	118	188	182	95	72	93	75	59	89	110	90	103

PLOT. . . . . CONCENTRATION VERSUS TIME
METHOD . . . . . HI VOL
UNITS . . . . . MICROGRAMS/CUBIC METER
STANDARDS . . . (FEDERAL) ANNUAL - 75 UG/CU.M

PARAMETER . . TOTAL SUSPENDED PARTICULATES
AREA. . . . . 0900, LINCOLN CO
SITE. . . . . 010, BROWN RESIDENCE
CITY. . . . . LIBBY

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Bureau intends to utilize teflon filters at the second location and perform a chemical mass balance analysis to identify source contributions. At this time the AQB is not positive of the second site's location, but it will most likely be within the city limits of Libby. The nephelometer site will be used in conjunction with the smoke management program and will only be operated from September through November.

Figure 3 shows the locations of the existing monitoring sites and the areas proposed for the new sites.

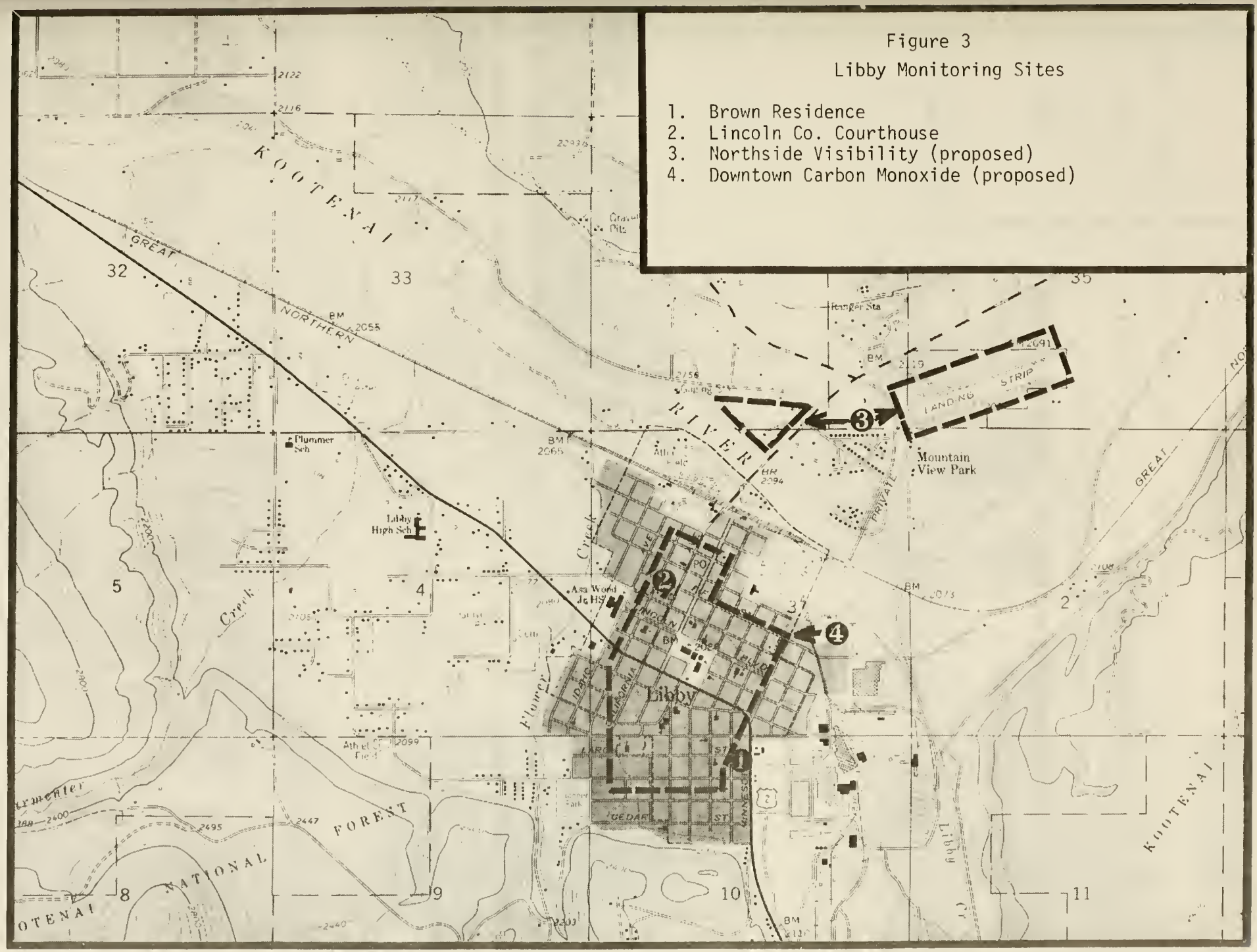


Figure 3
Libby Monitoring Sites
1. Brown Residence
2. Lincoln Co. Courthouse
3. Northside Visibility (proposed)
4. Downtown Carbon Monoxide (proposed)
KOOTENAI
GREAT NORTHERN
RIVER
Libby
Mountain View Park
LANDING STRIP
PRIVATE
Libby High Sch
Plummer Sch
Flower Creek
NATIONAL FOREST
KOOTENAI
32
33
35
5
4
3
2
8
9
10
11
1
2
3
4
5

Thompson Falls

1. Thompson Falls is a small town of 1500 people situated on the north side of the Thompson Falls reservoir. The reservoir is a small impoundment on the Clark Fork River. The Clark Fork River valley near Thompson Falls runs east and west, with mountains rising to 7000 feet to the north and south.

   Although all western Montana valleys are subject to severe temperature inversions during the fall and winter, the AQB suspects that the Clark Fork valley's orientation parallel to the prevailing west wind may improve the wintertime ventilation.

2. In accordance with the 1981 and 1982 Network Reviews, the AQB established a high volume sampler on the roof of the Sanders County Courthouse. The sampler is located near the back of the building approximately one-half block off Main Street. The area behind the Courthouse is a city park which extends to the next street with a residential area lying beyond. The site was established to sample particulates in the previously unmonitored downtown area. The AQB is attempting to determine TSP levels for most of western Montana's larger communities. Figure 4 shows the location of the Thompson Falls monitor.

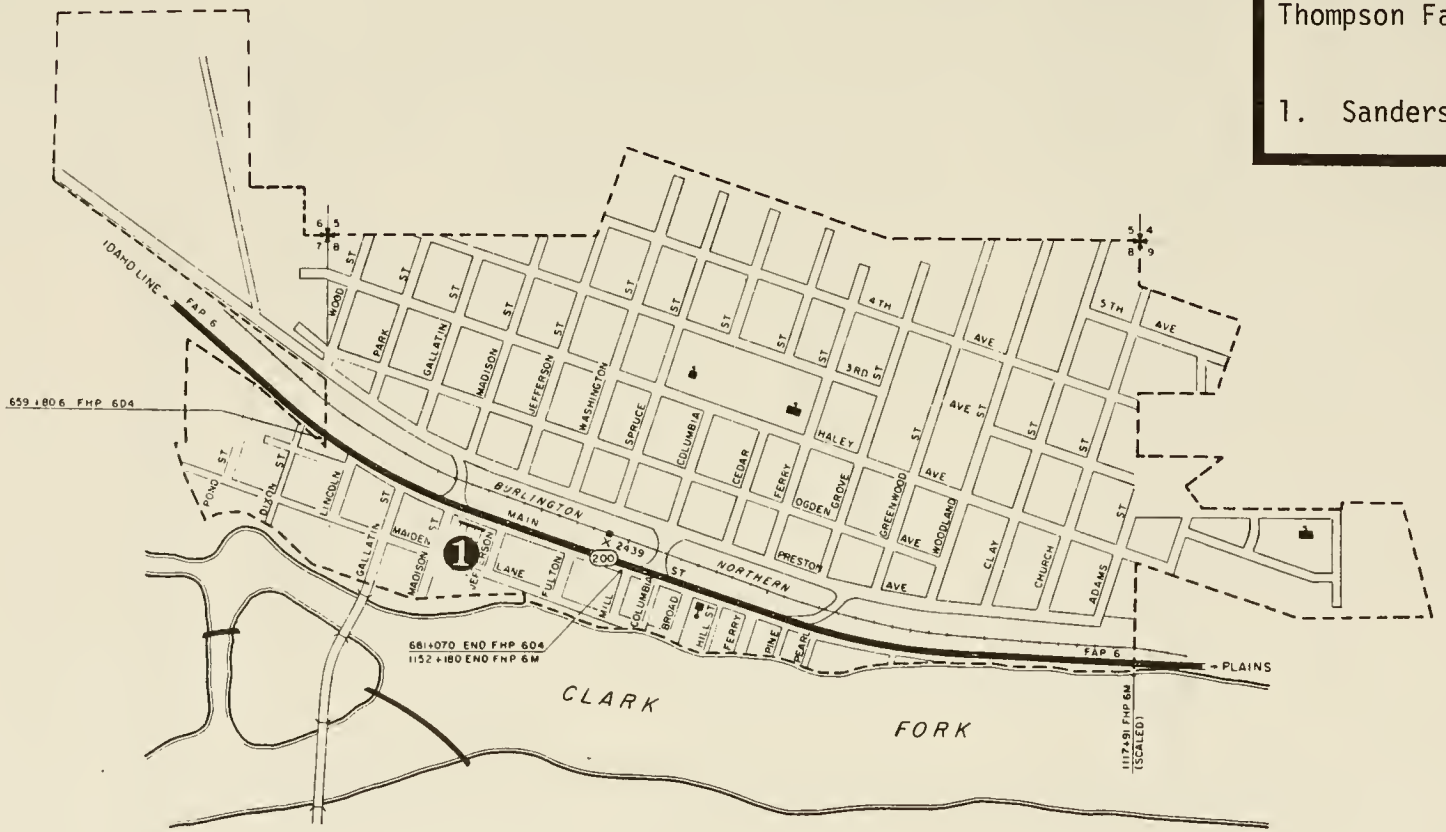
3. The Sanders County sanitarian's office started operating the sampler in January of 1983. To date there is insufficient data to make any conclusions. The AQB, with the assistance of the Sanders County Sanitarian, will operate the site for another year, analyze the data, and determine whether to continue or terminate the site.

Copies of this map are available for a nominal cost at the Montana Department of Highways—Helena, Montana 59601

Figure 4

Thompson Falls Monitoring Sites

1. Sanders Co. Courthouse



LEGEND

- PROPOSED ROAD
- GRADED AND DRAINED ROAD
- GRAVEL OR STONE ROAD
- LOW TYPE BITUMINOUS ROAD
- PAVED ROAD
- DIVIDED ROAD - TRAFFIC FLOW
- FAI FEDERAL AID INTERSTATE SYSTEM
- FAP FEDERAL AID PRIMARY SYSTEM
- FAS FEDERAL AID SECONDARY SYSTEM
- (90) INTERSTATE ROUTE MARKER
- (10) U S NUMBERED ROUTE MARKER
- (13) STATE ROUTE MARKER
- (382) OTHER ROUTE MARKER
- CORPORATE BOUNDARY LINE
- NON-EXISTENT DEDICATED STREET
- CENTRAL BUSINESS DISTRICT
- URBAN EXTENSION BOUNDARY
- RAILROAD AND STATION
- POST OFFICE
- COURT HOUSE
- ELEMENTARY SCHOOL
- HIGH SCHOOL
- HOSPITAL
- X 3939 ELEVATION

N

T 21 N R 29 W

CITY PLAT

THOMPSON FALLS

SANDERS COUNTY

MONTANA

1970 CENSUS 1,356

SCALE IN FEET

600 0 600 1200

REVISED DEC 31, 1976

Proposed Sites

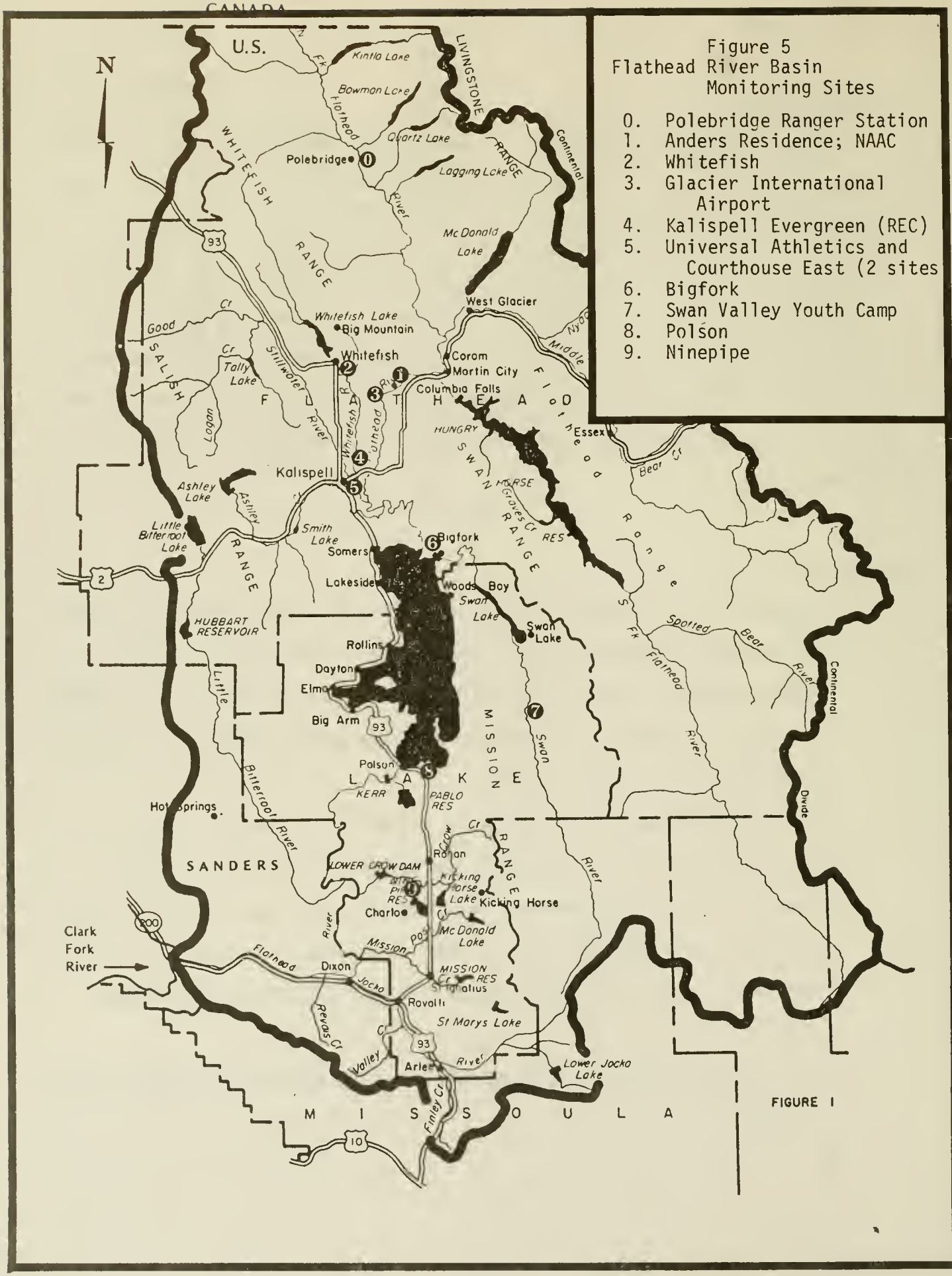
1. The AQB intends to establish a TSP data base for most of western Montana's larger communities. In light of the poor ventilation in western Montana, the Bureau considers that any community having a significant population has the possibility of having a particulate problem. Therefore, the AQB recommends new TSP monitoring sites in Eureka (population 1119) and Superior (population 1052).
2. In recent months the Bureau has received several complaints concerning blowing dust off the ASARCo tailings ponds near Troy. Therefore, the AQB is planning to establish a TSP site with chemical mass balance capabilities near the tailings ponds.

Flathead Valley

In June of 1983 the AQB completed a comprehensive monitoring effort in the Flathead Valley as part of the Flathead Basin Environmental Impact Study. The study was designed to establish environmental baselines and to determine the impact of a proposed coal mine just over the Canadian Border on the North Fork of the Flathead River. In addition to an extensive TSP sampling network, dichotomous samplers were located at six sites and nephelometers were operated at two locations. The Flathead Basin Environmental Impact Study was completed in June of 1983. Figure 5 shows the general location of monitoring sites within the Flathead Valley.

Whitefish

1. Whitefish is a community of 3700 people lying at the extreme north end of the upper Flathead Valley. The economy of the area is centered around tourism. The ventilation characteristics of the area are similar to other parts of the Flathead Valley, with poor dispersion conditions occurring during winter months.
2. The Whitefish monitor is located in a park in the western half of the city. This part of Whitefish is characterized by older residential homes. In 1982, the geometric mean for TSP was 49 ug/m^3 and the highest 24-hour reading was 138 ug/m^3. Table 24 provides additional TSP information for this site and allows for a comparison with other Montana sites.
3. Due to the relatively low concentrations, the site was shut down in July of 1983.


CANADA
U.S.
N
Figure 5
Flathead River Basin
Monitoring Sites
0. Polebridge Ranger Station
1. Anders Residence; NAAC
2. Whitefish
3. Glacier International Airport
4. Kalispell Evergreen (REC)
5. Universal Athletics and Courthouse East (2 sites
6. Bigfork
7. Swan Valley Youth Camp
8. Polson
9. Ninepipe
Kintla Lake
Bowman Lake
Quartz Lake
Logging Lake
Polebridge
Livingstone Range
Continental Divide
Whitefish Range
Flathead River
Mc Donald Lake
West Glacier
Whitefish Lake
Big Mountain
Whitefish
Coram
Martin City
Columbia Falls
Flathead
Essex
Hungry Horse Reservoir
Bear Cr
Swan Range
Spotted Bear River
Middle Fk Flathead River
Good Cr
Tally Lake
Stillwater River
Logan
Whitefish River
Kalispell
Ashley Lake
Ashley
Little Bitterroot Lake
Smith Lake
Somers
Bigfork
Lakeside
Woods Boy
Swan Lake
Hubbart Reservoir
Rollins
Dayton
Elmo
Big Arm
Swan
Mission Range
Polson
Lake
Kerr
Pablo Res
Hot Springs
Bitterroot River
Little
Sanders
Lower Crow Dam
Kicking Horse Res
Kicking Horse Lake
Charlo
Mc Donald Lake
Mission Cr Res
St Ignatius
Dixon
Jocko
Ravalli
St Marys Lake
Revais Cr
Valley
Arlee
Lower Jocko Lake
Finley Cr
Missoula
Clark Fork River
93
2
200
10
FIGURE 1

Polebridge

1. Polebridge is a very small community along the North Fork of the Flathead River 35 miles north of Columbia Falls and 20 miles south of the Canadian border. The valley runs north and south, with the Whitefish Range to the west and Glacier National Park to the east. An AQB wind system located nearby at Big Prairie indicated that winds in the North Fork are predominantly up and down the valley and very light.
2. The Polebridge site is located on the roof of a garage at the Polebridge Ranger Station in Glacier National Park. This site is essentially a background site, although emissions from a nearby dirt road may have some impact during the summer.

   The site was established to determine baseline particulate concentration and to analyze the impact of a proposed coal mine just north of the border in Canada. Since the mine may soon receive Stage II approval by the British Columbia government, the AQB intends to continue to operate this monitor at least until the proposed mine reaches full production.
3. Table 24 summarizes the TSP data for the Polebridge site while Figure 5 shows the general site location.

Columbia Falls

1. Columbia Falls is an industrial town of 3100 people located in the extreme northeast corner of the upper Flathead Valley. In the vicinity of Columbia Falls are a plywood-particle board-sawmill complex, two additional sawmills, and an aluminum reduction plant.

   Wind patterns in the area are dominated by drainage winds through Badrock Canyon and through a gap north of town which drains the North Fork of the Flathead River.

2. TSP has been monitored in Columbia Falls at the Anders residence for many years. In 1978 Columbia Falls was designated non-attainment for TSP based on this site. A subsequent microinventory performed by PEDCo ENVIRONMENTAL, INC. identified fugitive dust off paved and unpaved streets as accounting for over 90 percent of the TSP at this site. A paving project involving Nucleus Avenue, the main street of Columbia Falls, was completed in September of 1981.
3. Figure 6 locates the air monitoring sites in the vicinity of Columbia Falls. Table 24 summarizes TSP data from the Columbia Falls sites.
4. The Anders high volume sampler is located on the roof of a garage one block east of Nucleus Avenue. The sampler intake is approximately at the same height as the road surface. This area of Columbia Falls is primarily residential although it is adjacent to the downtown area.

1982 was the first full calendar year of sampling since the paving project was completed. Figure 7 displays the TSP concentrations at the Anders site for the last three years. The annual geometric mean for 1980 was 100 ug/m^3. In 1981 the year that the construction took place, the geometric mean increased 11 percent to 111 ug/m^3. The AQB believes the increase was caused by fugitive dust originating from construction activity. The AQB conducted an analysis for the 1982 Network Review that indicated for identical time periods the 1981 levels were above 1980 levels prior to and during the construction period, but much lower after construction was completed. In 1982, the year after construction was completed, the annual geometric mean was drastically reduced to 67 ug/m^3. Although there were statewide reductions in TSP during 1982, it is extremely unlikely that the recession and better than average dispersion conditions accounted for all of this 33 percent reduction.

Figure 6
Columbia Falls Monitoring Sites

1. Anders Residence
2. NAAC (shut down)

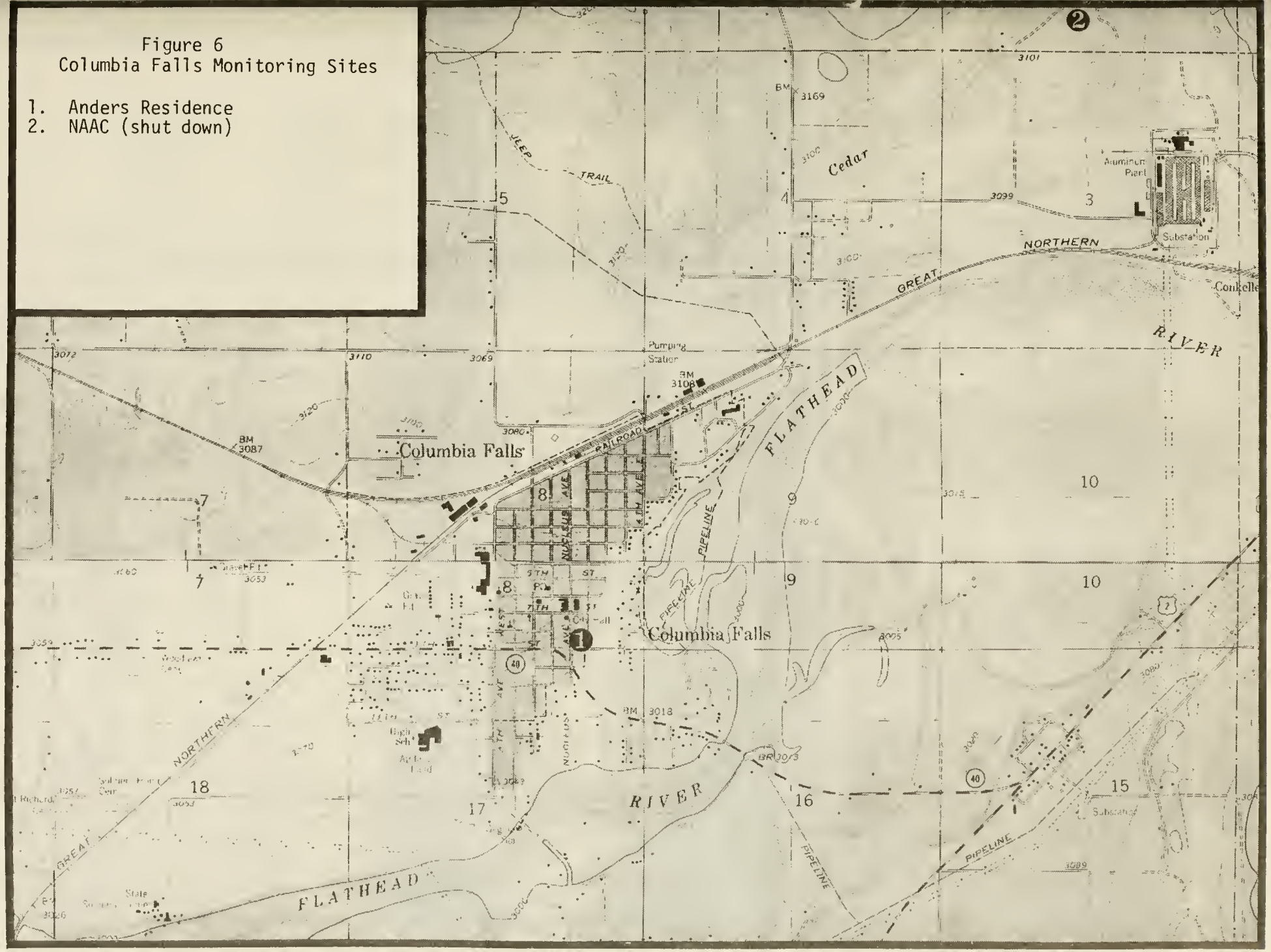
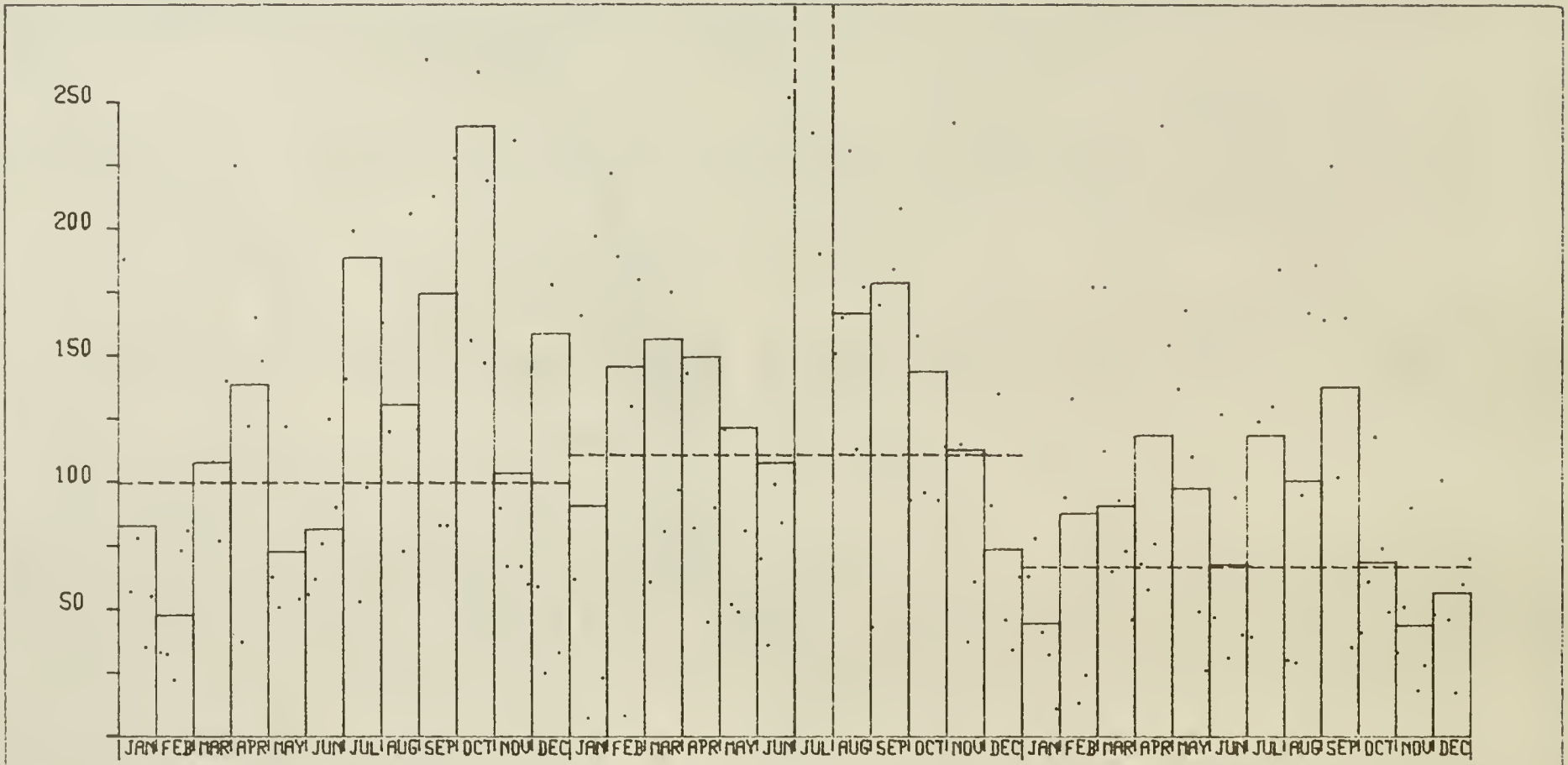


Figure 7



	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
NUM OBS	5	5	3	5	4	5	5	6	5	5	5	5
MO.AVG	83	48	108	139	73	82	189	131	175	241	104	159
GEO.AVG	100											

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
NUM OBS	5	5	5	5	5	5	5	5	5	6	5	5
MO.AVG	91	146	157	150	122	108	319	167	179	144	113	74
GEO.AVG	111											

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
NUM OBS	5	5	5	5	5	5	4	5	5	5	5	6
MO.AVG	45	88	91	119	98	68	119	101	138	69	44	57
GEO.AVG	67											

PLOT. . . . . CONCENTRATION VERSUS TIME
METHOD . . . . . HI VOL
UNITS . . . . . MICROGRAMS/CUBIC METER
STANDARDS . . . (FEDERAL) ANNUAL - 75 UG/CU.M

PARAMETER . . TOTAL SUSPENDED PARTICULATES
AREA. . . . . 0270, FLATHEAD CO
SITE. . . . . 005, ANDERS RESIDENCE
CITY. . . . . COLUMBIA FALLS

MONTANA STATE AIR QUALITY BUREAU

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5. The AQB will continue to operate the Anders residence site for SIP tracking.

6. The NAAC site was located outside of Columbia Falls in a forest opening approximately 0.5 miles north of the Anaconda Aluminum plant. It typically measured low levels of particulate but high levels of sulfates. The annual geometric mean for TSP at this site during 1982 was 25 ug/m^3. Due to the low levels of particulates and in accordance with the 1982 Network Review, the AQB discontinued this site in January of 1983.

7. The Glacier International Airport site is located in an open area to the northeast of the terminal. The airport is approximately five miles southwest of Columbia Falls and eight miles northeast of Kalispell. This site was the primary air monitoring site associated with the Flathead River Basin Environmental Impact Study. The AQB shut down TSP monitoring at this site in December of 1982.

Kalispell and Evergreen

1. Kalispell is the commercial center of the upper Flathead Valley. The city has a population of approximately 10,000 people, with perhaps an additional 10,000 living within three miles of the city. Evergreen is an extension of Kalispell to the northeast. It is home to about 5,000 people, and location for a sawmill and plywood plant. The upper Flathead Valley is predominantly agricultural; however, subdivisions have made inroads into the agricultural land base over the past ten years.

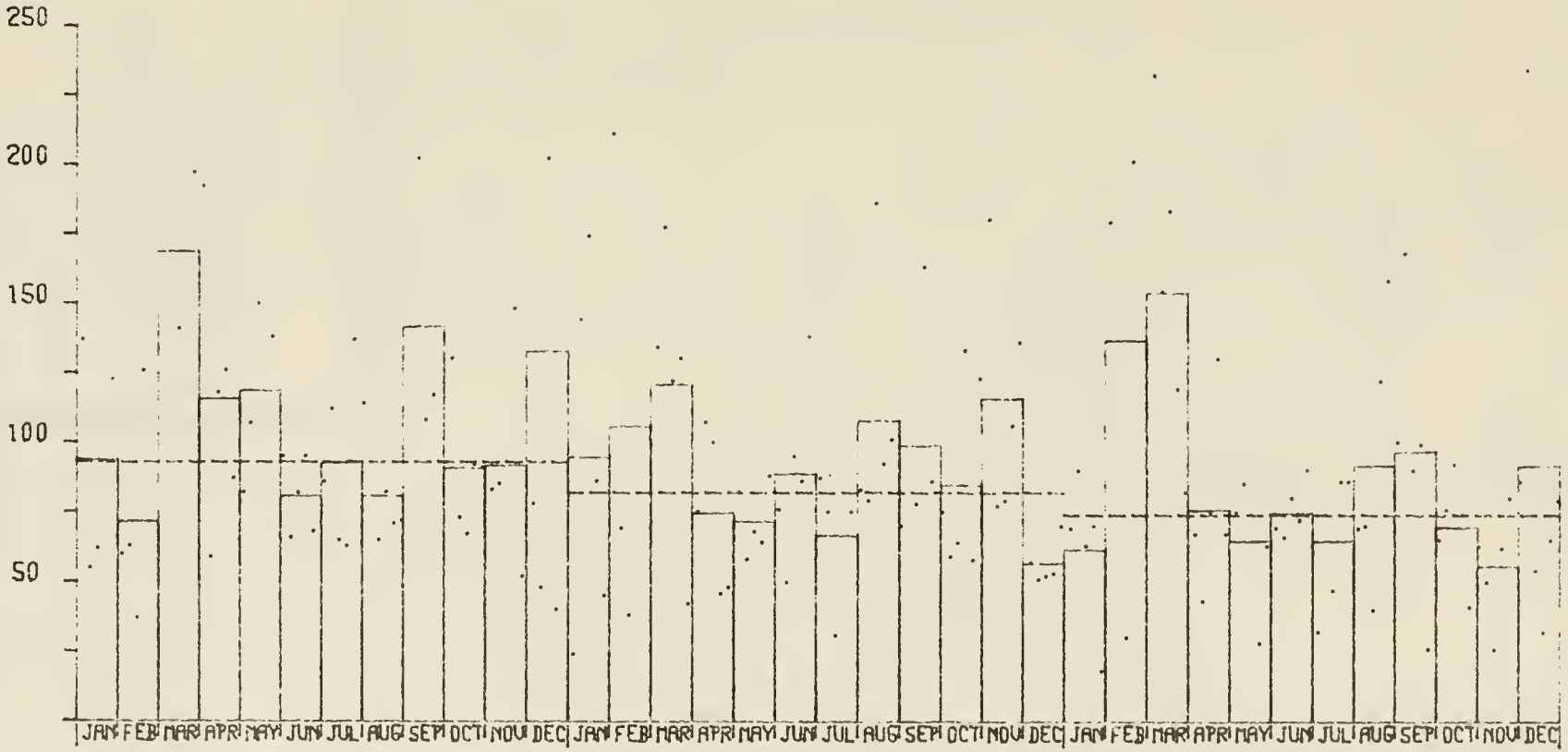
   The Flathead Valley experiences very poor dispersion conditions during the winter months. Winds in the valley are usually very light, blowing up and down the valley from the north or south.

2. During 1982 TSP levels in Kalispell and Evergreen decreased. The Universal Athletic site was down ten percent (see Figure 8), while the Evergreen site was down 17 percent. Similar to other areas of the state, the reduced concentrations are probably the result of the recession and better than average dispersion conditions.

3. Figure 9 locates the Kalispell and Evergreen monitoring sites. Table 24 summarizes particulate data for these sites.

4. TSP concentrations from the Universal Athletics site exceeded the federal secondary standards for annual average and individual 24-hour reading. The Evergreen site also exceeded the 24-hour secondary standard. 1982 is the first year since the site was established in 1979 that the Universal Athletics site complied with the federal primary standard.

   The lower readings in 1982 follow the statewide trend and are probably associated with better than average dispersion conditions and the recession. Future reductions may be realized with the completion of a paving project on Main Street in May of 1983.



NUM OBS	4	4	2	5	4	5	5	5	3	5	4	5	5	3	5	5	5	5	4	5	4	6	5	5	5	3	5	5	5	5	5	5	5	5	6
MO.AVG	94	72	169	116	119	81	93	81	142	91	92	133	95	106	121	75	72	89	67	108	99	85	116	57	62	137	154	76	65	75	65	92	97	70	56	92
GEO.AVG	93												82												74											

PLOT. . . . . CONCENTRATION VERSUS TIME
METHOD . . . . . HI VOL
UNITS . . . . . MICROGRAMS/CUBIC METER
STANDARDS . . . (FEDERAL) ANNUAL - 75 UG/CU.M

PARAMETER . . TOTAL SUSPENDED PARTICULATES
AREA. . . . . 0800, FLATHEAD CO
SITE. . . . . 015, UNIVERSAL ATHLETIC
CITY. . . . . KALISPELL

MONTANA STATE AIR QUALITY BUREAU

APRIL 1983

TECHNICAL SERVICES

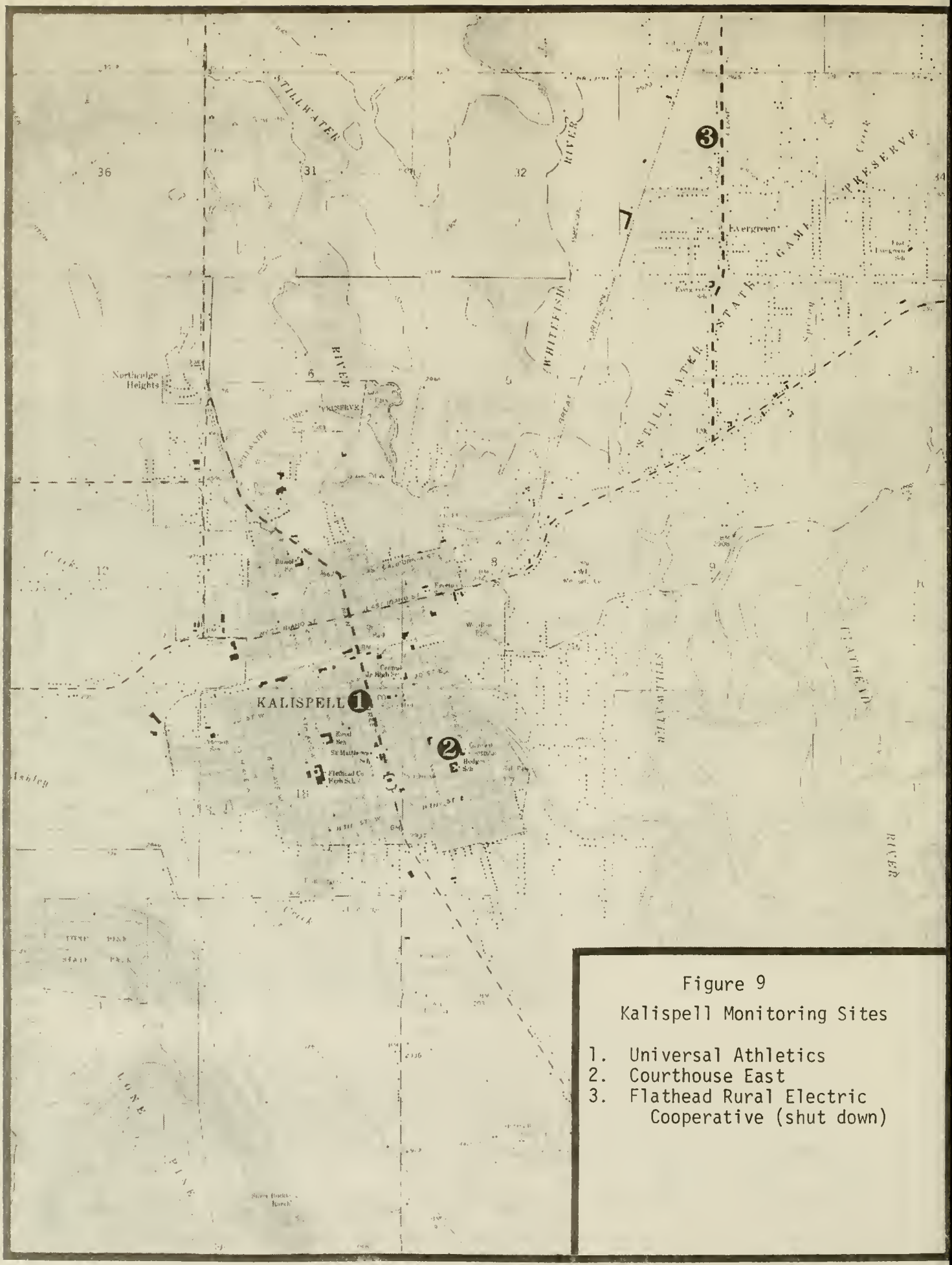


Figure 9

Kalispell Monitoring Sites

1. Universal Athletics
2. Courthouse East
3. Flathead Rural Electric Cooperative (shut down)

5. The Universal Athletics site is located on a rooftop one-half block off the main street of Kalispell. The site lies within the central business district.

Particulate concentrations at the Universal Athletics site are generally highest during late winter and early spring and again in late summer and early fall. Table 9 indicates this seasonal trend. The AQB suspects that the high levels in the early spring are caused by road dust associated with spring breakup.

The AQB with the cooperation of the Flathead County Sanitarian's office intends to continue to operate the Universal Athletics site to track Kalispell particulate concentrations.

TABLE 9

MONTHLY TRENDS IN TOTAL SUSPENDED PARTICULATE CONCENTRATIONS AT THE UNIVERSAL ATHLETICS SITE
Averages for 1980 through 1982

Month	No. of Samples	Concentration (ug/m^3)
Jan	14	83
Feb	10	101
Mar	12	101
Apr	15	89
May	14	83
Jun	15	82
Jul	14	76
Aug	15	94
Sep	12	109
Oct	16	82
Nov	14	88
Dec	16	94

6. In accordance with the 1982 Network Review, the AQB installed a new high volume sampler on the roof of the Flathead County Courthouse East. The sampler is located in an older residential area and was intended to help define the geographical extent of high TSP concentrations. With the assistance of the Flathead County Sanitarian's office, the AQB plans to operate this site at least through 1984.

7. The Evergreen site, also known as the Evergreen Rural Electrical Cooperative (REC) site, was located in an area characterized by a wide variety of land uses. Within a half mile of the site lies a plywood plant, sawmill, strip development, residential homes, trailer courts, and open undeveloped land.

   In accordance with the 1982 Network Review and due to continued low readings, the AQB shut the site down in December of 1982.

Big Fork

1. Big Fork is a town of 500 people situated on the East Shore of Flathead Lake at the mouth of the Swan River. The area's economy is primarily tourism. The town sits in rolling terrain extending from the river and lake up several hundred feet into the hills. The area is not only affected by synoptic winds but is also influenced by land-lake breezes.
2. The high volume sampler was located on a hill just northwest of town at the Big Fork Ranger Station. TSP levels were very low at this site, averaging 28 ug/m^3 in 1981 and 25 ug/m^3 in 1982. As a result, the AQB shut down the site in January of 1983.
3. Table 24 summarizes the TSP data.

Swan River

1. The Air Quality Bureau operated a high volume sampler at the Swan River Youth Camp for one year during 1982. The site was located on a lawn just to the west of a camp building. The surrounding area is heavily forested with rolling terrain typical of the Swan Valley.
2. The sampler recorded several high 24-hour readings during July, August and September. These high concentrations were probably caused by the construction of a new road just west of the site. Despite these readings, the geometric mean was only 23 ug/m^3.

   In light of the low annual average, the AQB shut down the site in January of 1983.
3. Table 24 summarizes the TSP data.

Polson

1. Polson is located at the southern end of Flathead Lake and is the commercial center for the south half of the Flathead Valley. The only significant industry in the area is the Flathead Lumber Company sawmill located two miles east of town.
2. The Polson sampler was located at the Mary Lozar residence near the intersection of Highways 93 and 35. The area around the site is primarily used for agriculture. The Flathead Lumber Company sawmill lies approximately 0.5 miles southwest of the site.

   TSP levels remained very low in 1982, with a geometric mean of 36 ug/m^3. With the conclusion of the Flathead River Basin Environmental Impact Study, the AQB shut down the Polson site in June of 1983. The Bureau anticipates that the Salish-Kootenai tribe will initiate future air monitoring in the Polson area.
3. Table 24 is a summary of the particulate data for Polson.

Ninepipe

1. The Ninepipe site was the primary AQB monitoring site in the lower Flathead Valley. It was operated as a part of the Flathead River Basin Environmental Impact Study. The site was located in a rural agricultural area just north of Highway 211 and the Ninepipe Reservoir.
2. In 1982 particulate concentration at the Ninepipe site averaged 13 ug/m^3. The site was shut down in July of 1983 at the conclusion of the Flathead Study. The Salish-Kootenai tribe is considering establishing an air monitoring site in this area.
3. Table 24 summarizes the TSP data for the site.

West Central Montana

West Central Montana includes Missoula, Powell and Ravalli Counties. The city of Missoula is the commercial hub of the area. This region is characterized by forested mountains and narrow valleys. The region experiences poor dispersion conditions during the winter months.

Missoula

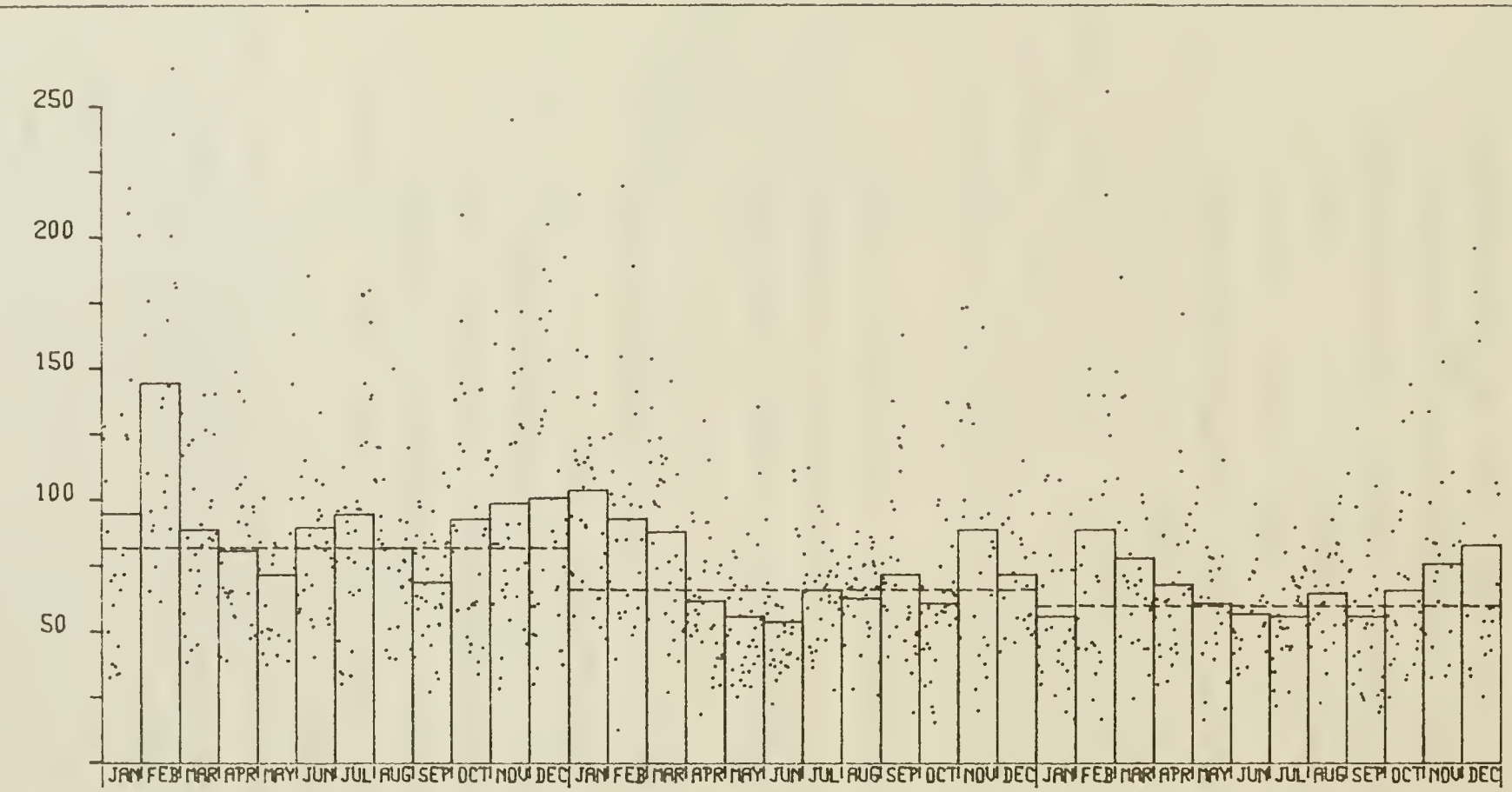
1. The City of Missoula lies within a deep mountain valley just above the confluence of the Clark Fork and Bitterroot Rivers. Over the past several years Missoula has experienced residential and commercial growth to the southwest onto the south hill and toward the small community of Lolo. In addition many nearby timbered canyons have experienced subdivision growth.

   Winds in the Missoula Valley are light, averaging 6.1 mph. Prevailing winds are from the west or northwest. During the fall and winter months Missoula is affected by severe temperature inversions. These inversions are extremely persistent, lasting for days or weeks at a time. During such inversions, very high concentrations of total suspended particulates have been recorded.

2. During 1982 the Missoula County Health Department operated five total suspended particulate monitoring sites in the metropolitan area of Missoula. They also perform calibrations and filter analysis for two particulate sites operated by Champion International near their kraft pulp mill at Frenchtown.

   Data from the Missoula particulate network indicated a downward trend in 1982. Particulate levels at the Courthouse Roof (see Figure 10) and Rose Park sites decreased 11 and 7 percent respectively. Although complete data for 1981 and 1982 at Boyd Park was unavailable, limited sampling showed a 46 percent decline. The two sites located near Frenchtown each registered 4 percent increases.

Figure 10



	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
NUM OBS	24	23	28	30	25	30	33	29	34	33	34	35	34	28	33	35	35	33	36	35	35	35	26	25	27	25	31	27	26	25	31	29	30	30	23	22
MO.AVG	95	145	89	81	72	90	95	82	69	93	99	101	104	93	88	62	56	54	66	63	72	61	89	72	56	89	78	68	61	57	56	65	56	66	76	83
GED.AVG	82												66												60											

PLOT. . . . . CONCENTRATION VERSUS TIME
METHOD . . . . . HI VOL
UNITS . . . . . MICROGRAMS/CUBIC METER
STANDARDS . . . (FEDERAL) ANNUAL - 75 UG/CU.M

PARAMETER . . TOTAL SUSPENDED PARTICULATES
AREA. . . . . 1100, MISSOULA CO
SITE. . . . . 001, COURTHOUSE ROOF
CITY. . . . . MISSOULA

MONTANA STATE AIR QUALITY BUREAU

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3. None of the Missoula samplers recorded valid annual averages in excess of the Montana or federal primary standards during 1982. Although the Boyd Park site had an average over the federal secondary standard, there was insufficient data to constitute a valid annual average.

   The federal 24-hour primary standard was violated at both Boyd Park and Rose Park. Boyd Park recorded the highest 24-hour reading (381 ug/m^3) in the entire state of Montana. The Montana 24-hour standard of 200 ug/m^3 was violated at the Boyd Park, Courthouse Roof, and Rose Park sites. The Northside, Lolo, Hoerner Waldorf #1 and Hoerner Waldorf #2 sites were all in compliance.

   Figures 11 and 35 show the geographical locations of the Missoula monitoring sites. Tables 10 and 11 describe the statistical results for the various comparisons made on the Missoula data.

4. During 1982 the Missoula County Health Department established two new particulate monitoring sites. These special purpose monitors were located in opposite directions from the center of Missoula: one in the small community of Lolo and the other on the northside of Missoula. Both sites were chosen in accordance with the 1982 Network Review.

5. The Missoula County Courthouse is located in a commercial district along Broadway 1.5 blocks west of the intersection of Broadway and Higgins Avenue. The Courthouse Roof site has been continuously operated for over ten years and provides a sound historical data base. The 1982 geometric mean was 55 ug/m^3 and the highest 24-hour reading was 256 ug/m^3.

   The particulate data from the Courthouse Roof sampler correlated very well with the data from the Northside (R=.8938) and Rose Park (R=.8582) sites and well with the Boyd Park (R=0.7844) site. Although the best correlation was with the Northside data, the t-test indicated

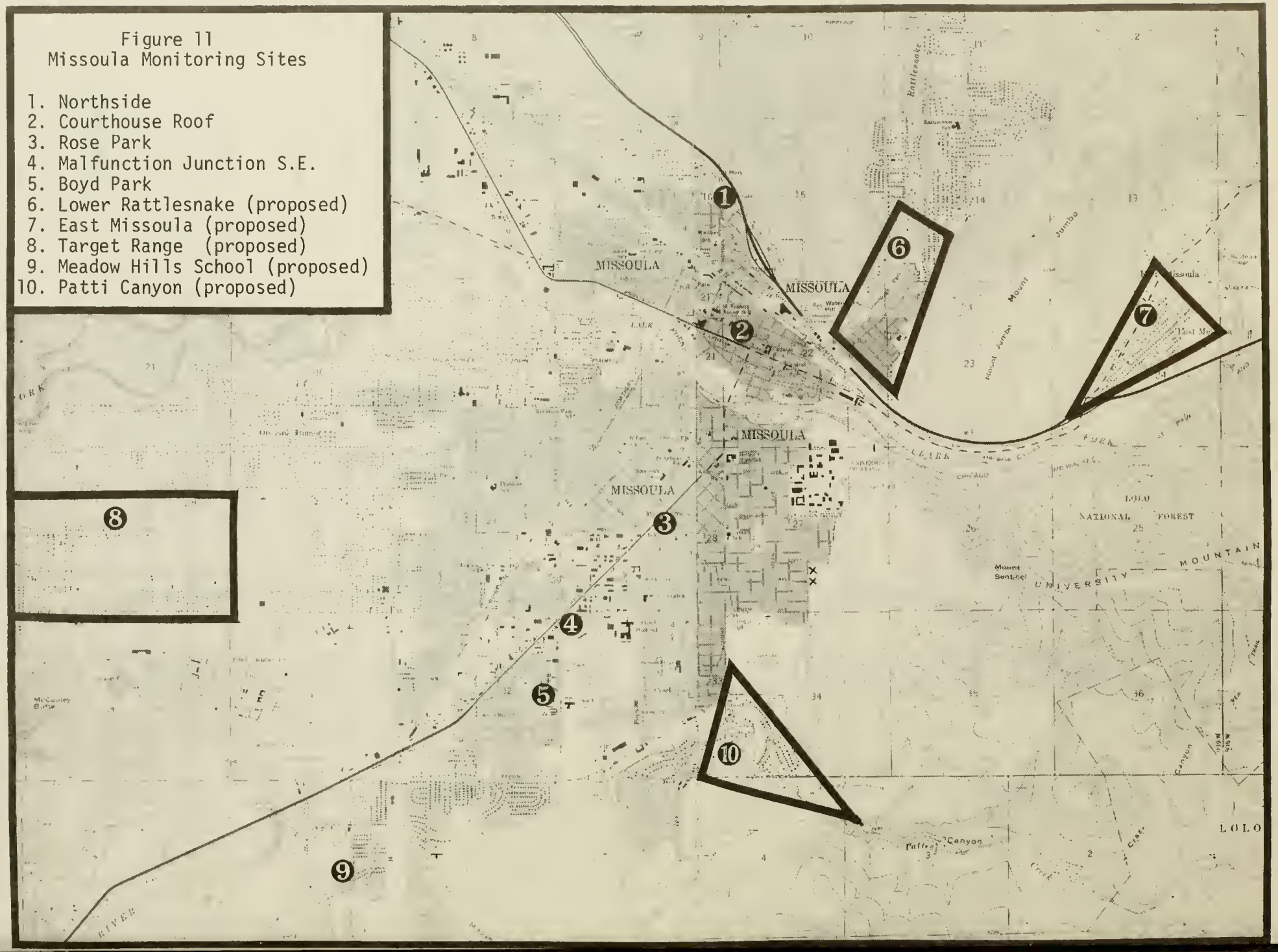


Figure 11
Missoula Monitoring Sites
1. Northside
2. Courthouse Roof
3. Rose Park
4. Malfunction Junction S.E.
5. Boyd Park
6. Lower Rattlesnake (proposed)
7. East Missoula (proposed)
8. Target Range (proposed)
9. Meadow Hills School (proposed)
10. Patti Canyon (proposed)
MISSOULA
MISSOULA
MISSOULA
MISSOULA
LOLO
NATIONAL FOREST
UNIVERSITY
MOUNTAIN
LOLO

TABLE 10

CORRELATION COEFFICIENTS OF TOTAL SUSPENDED PARTICULATE DATA FROM MISSOULA MONITORING SITES

	Courthouse Roof	Rose Park	Boyd Park	Northside
Courthouse Roof	---	0.8582 (315) P=0.000	0.7844 (104) P=0.000	0.8938 (22) P=0.000
Rose Park	0.8582 (315) P=0.000	---	0.8240 (112) P=0.000	0.8824 (27) P=0.000
Boyd Park	0.7844 (104) P=0.000	0.8240 (112) P=0.000	---	0.9132 (25) P=0.000

Note: 0.8582 = correlation coefficient
(315) = number of data pairs
P=0.000 = one tailed probability

TABLE 11

T-TEST RESULTS OF THE COMPARISON OF TOTAL SUSPENDED PARTICULATE DATA FROM MISSOULA MONITORING SITES

	Courthouse Roof	Rose Park	Boyd Park	Northside
Courthouse Roof	---	3.4308 21.928 2.78 P=0.006	-17.2010 37.642 - 4.66 P=0.000	17.8864 18.570 4.52 P=0.000
Rose Park		---	-24.3696 35.993 - 7.17 P=0.000	15.6444 21.188 3.84 P=0.001
Boyd Park			---	85.7280 48.658 8.81 P=0.000

Note: 3.4308 = mean of the differences
21.928 = standard deviation of the differences
2.78 = t value
P=0.006 = two tailed probability

that the two sites do not have equivalent means. As expected, the data correlation with Boyd Park was weaker than with Rose Park. Apparently TSP concentrations in the south part of the Missoula valley are being influenced by a slightly different source mix. However it should be noted that data from all Missoula sites correlate quite well.

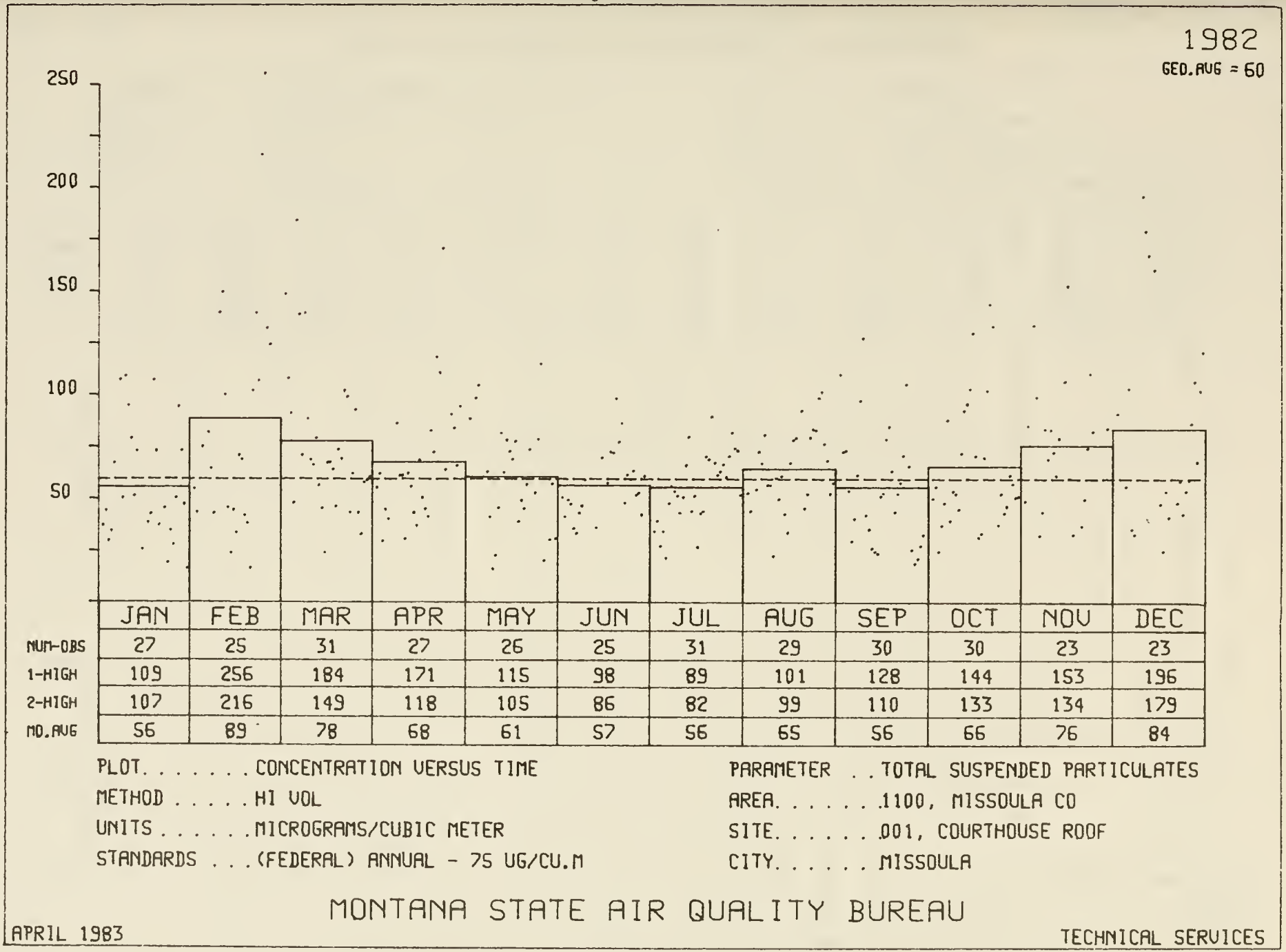
Figure 12 displays monthly trends of particulate concentrations at the Courthouse Roof site during 1982. In general higher TSP levels are recorded in the winter months than during the summer months. This trend is even more pronounced at other sites, such as Boyd Park and Rose Park (see figure 13). The AQB suspects that road dust during the snow free months may be causing higher TSP readings at the Courthouse and creating less winter to summer fluctuations than the other sites.

Results from an emission inventory and a chemical mass balance study indicate that smoke from residential wood burning is the major winter-time emission source. When these emissions are injected at almost ground level into Missoula extremely stable winter atmsophere, high TSP levels result. High carbon monoxide concentrations late at night and in residential areas tend to reinforce this fact.

Due to consistently high TSP levels and the historical significance of this site, the Missoula County Health Department intends to continue to operate it. However the site will be modified during the fall of 1983 to ensure proper spacing between the two recording samplers.

6. Rose Park is located within a residential area near the geographical center of Missoula. However, a major arterial, Brooks Avenue, passes within one block of the sampler. In 1982 Rose Park recorded a geometric mean of 52 ug/m^3 and a 24-hour high of 381 ug/m^3. 381 ug/m^3 was the highest 24-hour reading in the entire state network during 1982.

Figure 12



	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
NUM-OBS	27	25	31	27	26	25	31	29	30	30	23	23
1-HIGH	109	256	184	171	115	98	89	101	128	144	153	196
2-HIGH	107	216	149	118	105	86	82	99	110	133	134	179
MO.AVG	56	89	78	68	61	57	56	65	56	66	76	84

PLOT. . . . . CONCENTRATION VERSUS TIME
METHOD . . . . . HI VOL
UNITS . . . . . MICROGRAMS/CUBIC METER
STANDARDS . . . (FEDERAL) ANNUAL - 75 UG/CU.M

PARAMETER . . TOTAL SUSPENDED PARTICULATES
AREA. . . . . 1100, MISSOULA CO
SITE. . . . . 001, COURTHOUSE ROOF
CITY. . . . . MISSOULA

MONTANA STATE AIR QUALITY BUREAU

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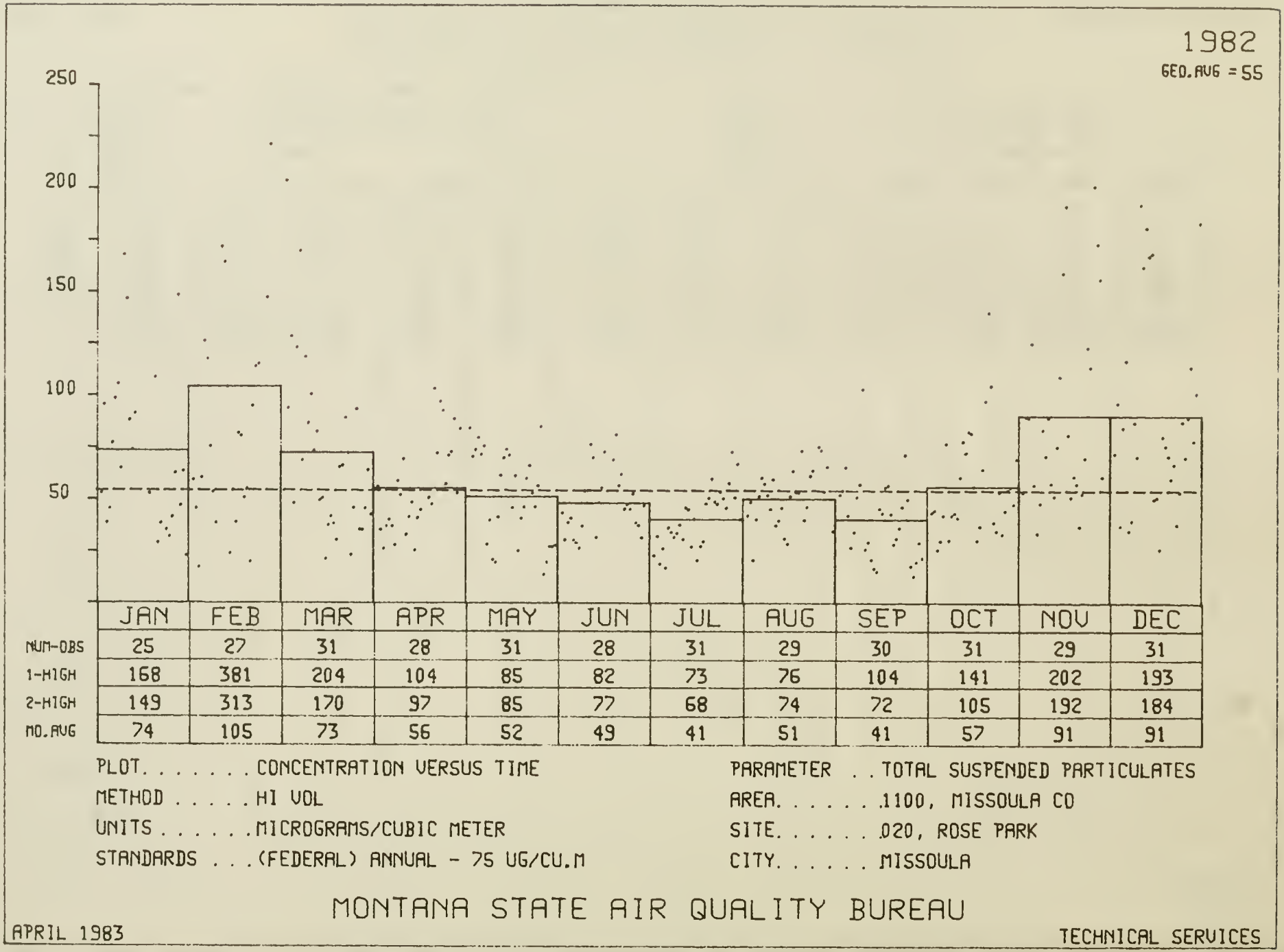
Figure 13



	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
NUM-OBS	25	27	31	28	31	28	31	29	30	31	29	31
1-HIGH	168	381	204	104	85	82	73	76	104	141	202	193
2-HIGH	149	313	170	97	85	77	68	74	72	105	192	184
MO.AVG	74	105	73	56	52	49	41	51	41	57	91	91

PLOT. . . . . CONCENTRATION VERSUS TIME
METHOD . . . . . HI VOL
UNITS . . . . . MICROGRAMS/CUBIC METER
STANDARDS . . . (FEDERAL) ANNUAL - 75 UG/CU.M

PARAMETER . . TOTAL SUSPENDED PARTICULATES
AREA. . . . . 1100, MISSOULA CO
SITE. . . . . 020, ROSE PARK
CITY. . . . . MISSOULA

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TSP concentrations at the Rose Park site showed very good correlation with all other Missoula sites. Perhaps the sites geographical location near the center of the valley and the rest of the sampling network is partially responsible for this relationship.

The TSP concentrations at Rose Park are highest during the winter (see figure 13). The arithmetic average for the winter months (January, February, March, October, November and December) was 81 ug/m^3 while the summer months (April through September) averaged 48 ug/m^3.

The Rose Park site is equipped with four high volume samplers and a GCA Beta gauge. It is the focal point of Missoula's wintertime emergency episode program. Two of the high volume samplers alternate run days so that daily sampling is achieved. One of the other two samplers is used as a colocated sampler while the other is operated as a short-term monitor during air pollution episodes. The Beta gauge provides continuous particulate data during episodes. Although there has been some interest on the part of Missoula citizens to move the episode monitoring system to Boyd Park, it will remain at Rose Park at least through the winter of 1983 and 1984.

The Missoula County Health Department will continue to operate TSP monitoring at Rose Park at least for another calendar year. However, the meteorological system will either be shut down or moved to the Boyd Park site. The close proximity of trees at the Rose site make wind monitoring inappropriate. In addition, the operation of the colocated TSP sampler will be increased to a one-in-three day cycle in accordance with federal requirements for daily sampling.

7. The Boyd Park monitoring site is located in a residential area on the south side of the city just below the South Hill. Missoula County personnel believe that this part of town has the highest TSP concentrations.

This hypothesis is reinforced by the fact that the highest geometric mean (75 ug/m^3) for 1982 in Missoula was recorded at Boyd Park.

The high concentrations of particulates are most likely caused by wood smoke emissions and extremely poor dispersion. A survey conducted in 1980 indicated that this area of Missoula has the highest per capita firewood use.

The Boyd Park particulate data correlated extremely well (R=.9132) with the data from the Northside site, very well (R=.8240) with Rose Park and well (R=.7844) with the Courthouse Roof site. It is difficult to understand why Boyd Park data correlated so well with the Northside site. The Northside site is located in an open grassy area near a cemetery and at least 300 yards from the nearest residence. The physical characteristics of the two sites are very different. However, as stated earlier, poor dispersion characteristics throughout the Missoula valley tend to cause readings at all sites to respond similarly.

Due to the high readings, the Missoula County Health Department will continue to monitor TSP at Boyd Park. In addition, daily TSP monitoring may be initiated at Boyd Park if manpower and equipment becomes available.

8. In October of 1982 Missoula County installed a new TSP site on the Northside of Missoula. The site is in a grassy area near a cemetery. The Missoula White Pine and Sash sawmill and factory is located approximately 0.75 miles to the southeast while the Louisiana Pacific particleboard plant is 0.75 miles to the northwest. The site was initiated as a result of the 1982 Network Review and to investigate particulate concentrations in a previously unmonitored area. The Missoula County Health Department is finding it necessary to develop a better

understanding of the geographical distribution of particulate concentrations in order to better define the area to be regulated under the agency's emergency episode plan.

Since the TSP levels have been relatively low, Missoula County personnel intend to relocate this site during the late fall of 1983.

9. The Lolo site was established during November of 1982 to determine particulate levels south of Missoula. The site is located below and on the northside of a small hill which rises onto a bench. The sampler intake is approximately 10 feet above ground level and three feet above the surface of the bench area. The area immediately to the north and east is swampy with some cottonwoods and Ponderosa pine present. A subdivision is adjacent to the south and the center of Lolo is approximately 0.3 miles to the southwest. Particulate concentrations have generally been low and the Missoula County Health Department will relocate the site during the fall of 1983.

10. In an attempt to further define the geographical distribution of particulates in the Missoula atmosphere, the county intends to relocate the Northside and Lolo samplers to two of the following locations: (1) the lower Rattlesnake area, (2) Target Range, (3) East Missoula, (4) Meadow Hills School, or (5) Patti Canyon. The remainder of the proposed sites will be monitored when equipment becomes available, hopefully in late 1983.

The Target Range area was recommended as a possible monitoring site in both the 1981 and 1982 Network Reviews. This area has a significant human population and has been unmonitored for at least five years.

East Missoula is separated from Missoula by a constriction in the Clark Fork Valley known as Hellgate Canyon. Missoula County is interested in determining TSP levels in this area.

The Lower Rattlesnake is situated near the point where the Rattlesnake Canyon opens into the Missoula valley. County personnel suspect that wood smoke emissions from the residential areas extending up the canyon drift down slope until particulate levels are maximized in this area.

The Meadow Hill School is located in the southwest corner of Missoula approximately 1.5 miles southwest of Boyd Park. The Missoula County Health Department suspects this area of the city is impacted by very high particulate levels.

Patti Canyon is a residential area which extends from the southeast corner of Missoula up into the forested hills. The area has never been monitored for TSP in the past.

11. Champion Packaging Division operates two high volume samplers near their pulp mill in Frenchtown. The Missoula County Health Department calibrates these samplers and performs the filter analyses. TSP readings are usually quite low, but sulfates are elevated.

The Missoula County Health Department and the AQB recommend that these sites continue to be operated with some modifications. The samplers are presently being operated using rotometers for flow measurement. Since the AQB no longer recognizes rotometers as a valid flow measuring device, the sampler must be re-equipped with a continuous flow recorder, such as a transducer and chart recorder.

Hamilton

1. Hamilton is a community of 2600 people lying in the center of the Bitterroot Valley approximately 50 miles south of Missoula. The elevation of Hamilton is approximately 3550 feet or about 300 feet higher than Missoula.

   Hamilton often experiences much better wintertime ventilation than nearby Missoula. On many occasions when Missoula is fogged in and experiencing high TSP concentrations, Hamilton is sunny and relatively clear. The AQB speculates that the downslope drainage winds cause the nighttime cold air to move through Hamilton and pool near Missoula. This cold air is often associated with fog which prevents the sun from reaching the ground and heating up the surface layer of air. However, Hamilton is generally above the cold air layer.

2. As recommended in the 1982 Network Review, the AQB installed a TSP monitor in Hamilton during March of 1983. The high volume sampler is operated by the Ravalli County sanitarian's office. The Bureau will review the data from the Hamilton site in conjunction with the 1984 Network Review and decide whether continued monitoring is warranted.
3. Figure 14 shows the location of the site.

Ovando

1. Montana operates two background samplers, one at the Smith Ranch near Ovando in western Montana and the other at the Billing Ranch near Jordan in eastern Montana.
2. The Smith Ranch site is located in the sparsely populated upper Blackfoot Valley. The entire area is used almost exclusively for hay production and livestock grazing. The 1982 geometric mean (14 ug/m^3)

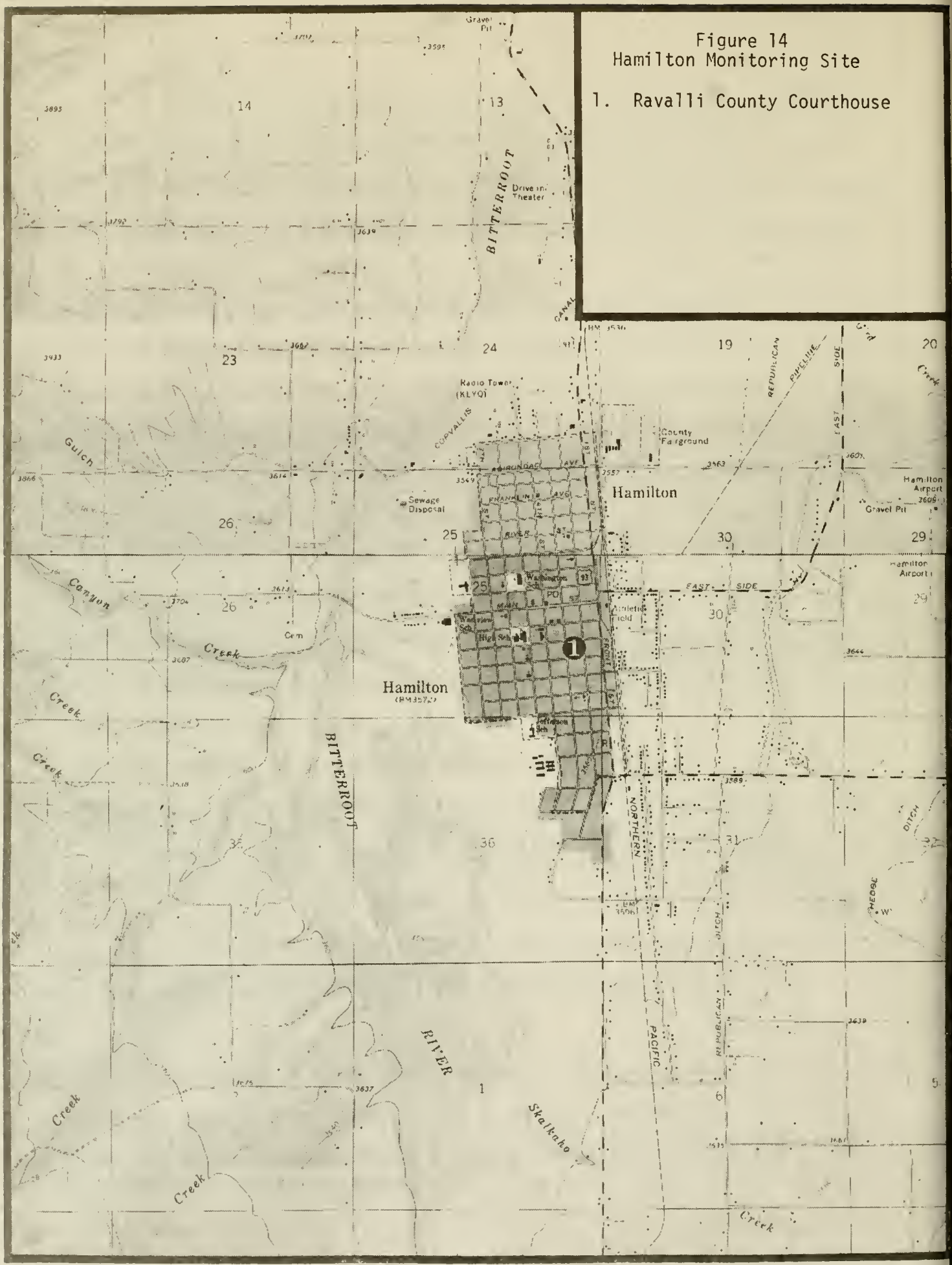


Figure 14
Hamilton Monitoring Site
1. Ravalli County Courthouse
Hamilton
Hamilton
BITTERROUT
BITTERROUT
RIVER
Skalkaho
Creek
Gulch
Canyon
Drive-in Theater
Radio Tower (KLYQ)
Sewage Disposal
County Fairground
Gravel Pit
Hamilton Airport
Athletic Field
NORTHERN PACIFIC
REPUBLICAN PIPELINE
EAST SIDE
FRONT
MAIN
RIVER
GRANDAD AVE
FRANKLIN AVE
DITCH
CANAL
1

and highest 24-hour reading (79 ug/m^3) at the Smith Ranch are both very low, indicating the site is serving its purpose.

3. Table 24 summarizes the Ovando data and Figure 35 shows the site location.

Proposed Site

The Air Quality Bureau intends to establish a TSP data base for most of western Montana's larger cities. Deer Lodge (pop. 4000) is the only community in west central Montana that meets this criteria. The AQB intends to monitor in Deer Lodge in an area between Cottonwood and Pennsylvania Avenues and within four blocks of Main Street (see Figure 15).

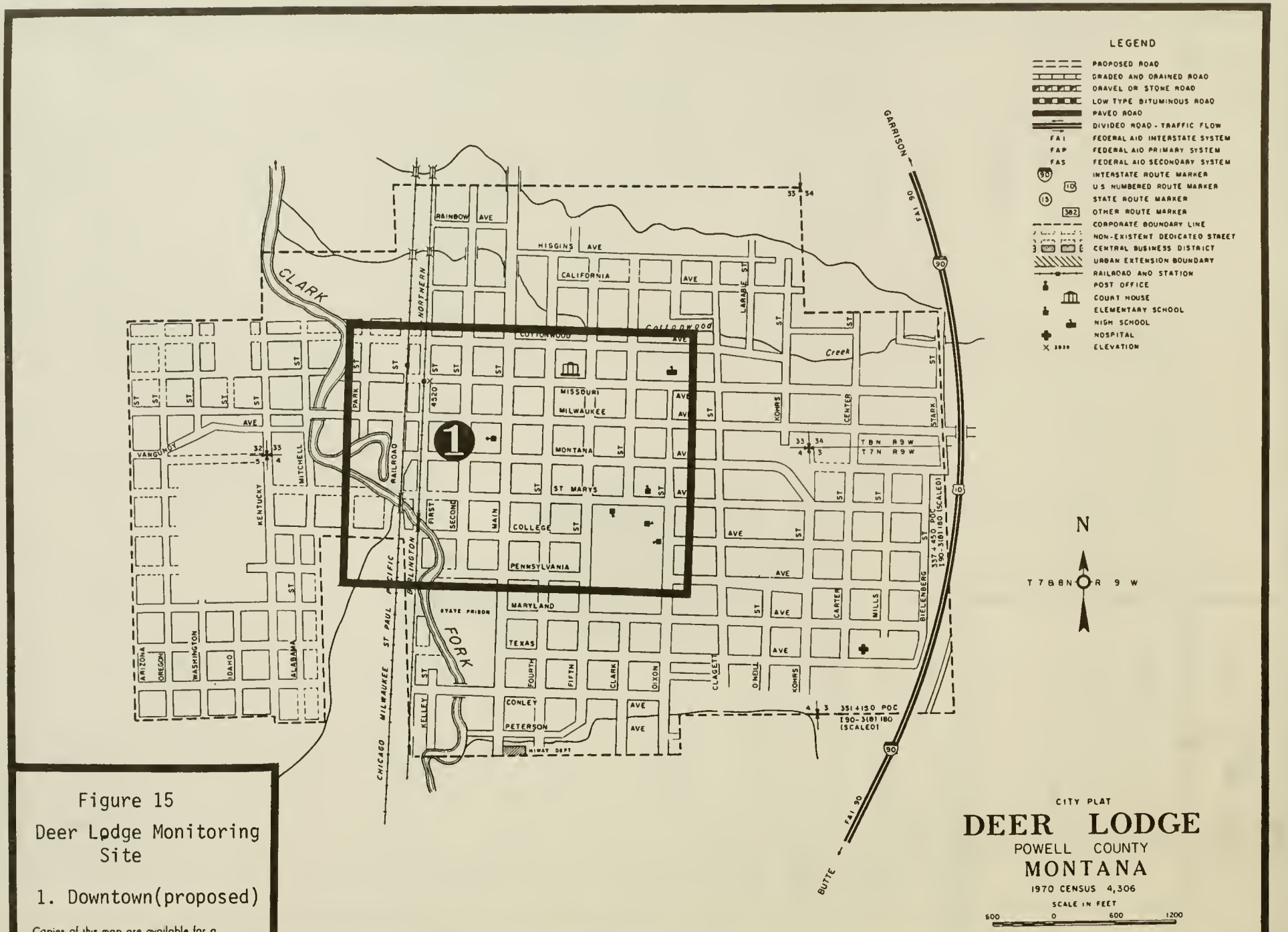


Figure 15

Deer Lodge Monitoring Site

1. Downtown(proposed)

Copies of this map are available for a nominal cost at the Montana Department of Highways—Helena, Montana 59601

Southwest Montana

Southwest Montana includes Beaverhead, Broadwater, Deer Lodge, Jefferson, Gallatin, Lewis and Clark, Madison, Meagher and Silver Bow Counties. This region also has very high mountains; however, the valleys are considerably wider than the valleys of extreme western Montana. Winter dispersion conditions are better than for western central or northwest Montana but severe temperature inversions do occur.

Helena

1. The City of Helena is situated near the south end of the Helena valley. The elevation of the city varies from 3850 feet in the north part of Helena to over 4200 feet at the extreme southern edge of the city. The Helena valley is similar to other western Montana mountain valleys. Prevailing winds are generally light (average - 7.5 mph) and from a southwest, west, or northwest direction. The valley is also prone to pollutant trapping temperature inversions, especially during the late fall and early winter.
2. Total suspended particulate levels in Helena showed almost no change from 1981 to 1982. Only the Capital Courts and the Cogswell Building sites had sufficient data to make year to year comparisons. The Capital Courts monitor recorded a 2 percent reduction, while the Cogswell Building increased 4 percent. It should be noted that a new water line was installed in the street in front of the Cogswell Building during the summer of 1982. The construction associated with the water line was probably a significant source of dust.
3. The Capital Courts and Super Save Grocery sites exceeded the federal short-term secondary standards during 1982. 24-hour concentrations of 183 ug/m^3 and 166 ug/m^3 were recorded at the Capital Courts location,

while the Super Save Grocery recorded high readings of 188 ug/m^3 and 166 ug/m^3. Table 24 provides additional information concerning Helena particulate levels.

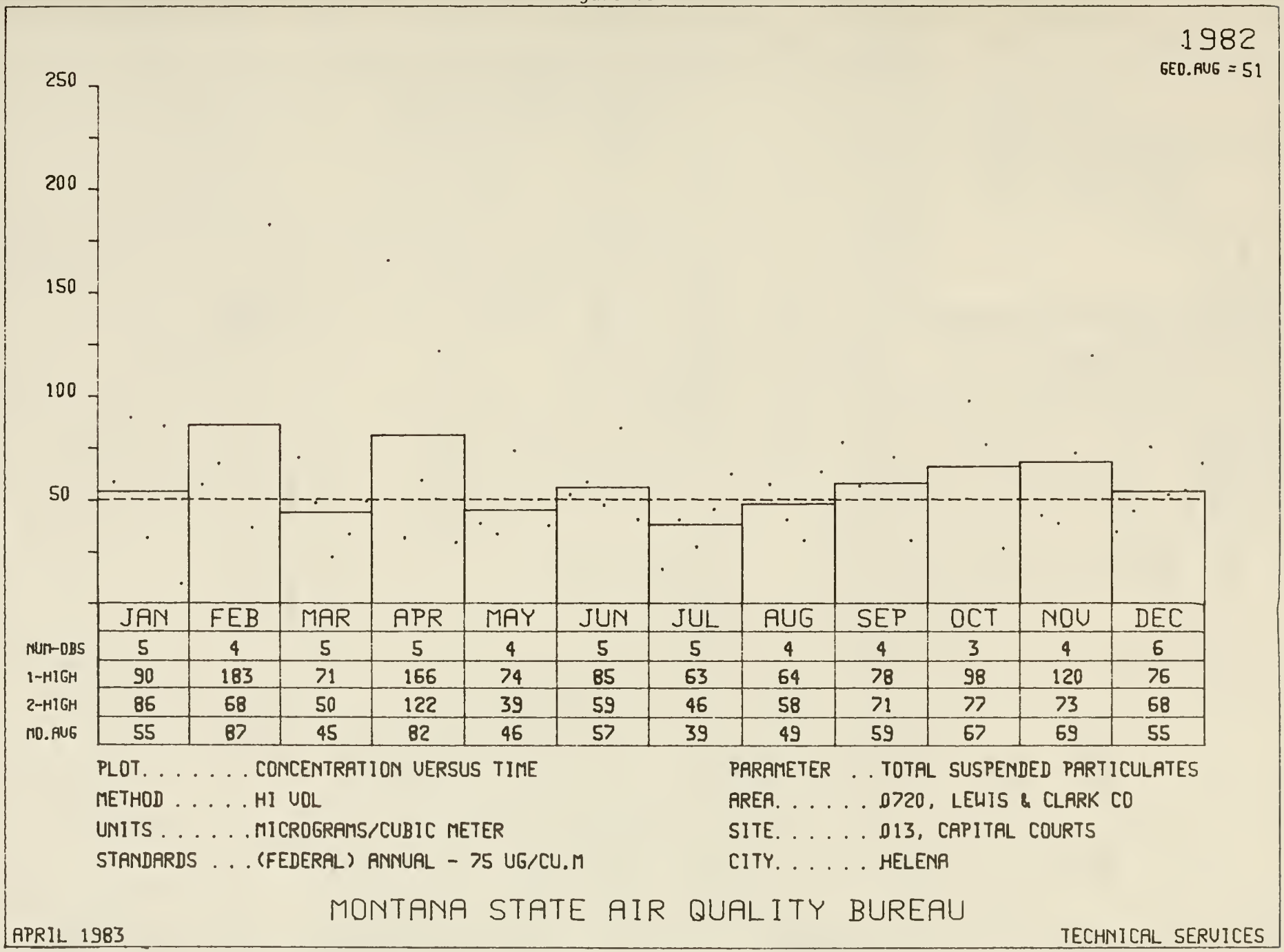
4. The AQB plotted 1982 monthly TSP data for the Capital Courts site (Figure 16). Although the plot did not show any definite seasonal trends, the highest concentrations occurred in February, April, and November.

5. Tables 12 and 13 provide summaries of the statistical analyses performed on the Helena TSP data. Figure 17 is a map showing the locations of the monitoring sites.

6. The Cogswell Building is part of the Capital complex which lies in the south side of Helena at an elevation of 4120 feet. The area surrounding the capital complex is generally residental with older homes to the south and west and newer homes to the north and east. The Prospect and 11th Avenue strip development is located approximately four blocks to the north.

   Particulate levels measured at the Cogswell Building correlated poorly with data from the Capital Courts (R=0.4289) and Super Save Grocery (R=0.2855) sites. These results are quite different from the results of a similar analysis performed in conjunction with the 1981 Network Review. According to the 1983 analysis, the Cogswell Building monitor is being influenced by different emission sources than the other two sites. The dust associated with the installation of the water main may be a unique source which is responsible for the poor correlation with other sites. In addition, the Cogswell Building is often above the wintertime temperature inversions, while the other sites are below.

Figure 16



	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
NUM-OBS	5	4	5	5	4	5	5	4	4	3	4	6
1-HIGH	90	183	71	166	74	85	63	64	78	98	120	76
2-HIGH	86	68	50	122	39	59	46	58	71	77	73	68
MO.AVG	55	87	45	82	46	57	39	49	59	67	69	55

PLOT. . . . . CONCENTRATION VERSUS TIME
METHOD . . . . . HI VOL
UNITS . . . . . MICROGRAMS/CUBIC METER
STANDARDS . . . (FEDERAL) ANNUAL - 75 UG/CU.M

PARAMETER . . TOTAL SUSPENDED PARTICULATES
AREA. . . . . 0720, LEWIS & CLARK CO
SITE. . . . . 013, CAPITAL COURTS
CITY. . . . . HELENA

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TABLE 12

CORRELATION COEFFICIENTS OF TOTAL SUSPENDED PARTICULATE DATA FROM HELENA MONITORING SITES

	Cogswell Building	Capital Courts	Super Save Grocery
Cogswell Building	--	0.4289 (32) P=0.007	0.2855 (24) P=0.088
Capital Courts	0.4289 (32) P=0.007	--	0.7151 (40) P=0.000

Note: 0.4289 = correlation coefficient
(32) = number of data pairs
P=0.007 = one tailed probability

TABLE 13

T-TEST RESULTS OF THE COMPARISON OF TOTAL SUSPENDED PARTICULATE DATA FROM HELENA MONITORING SITES

	Cogswell Building	Capital Courts	Super Save Grocery
Cogswell Building	--	-5.4063 30.614 - 1.00 P=0.326	-13.9583 42.316 - 1.62 P=0.120
Capital Courts		--	- 5.6250 26.017 - 1.37 P=0.179

Note: - 5.4063 = mean of the differences
30.614 = standard deviation of the differences
- 1.00 = t-value
P=0.326 = two tailed probability

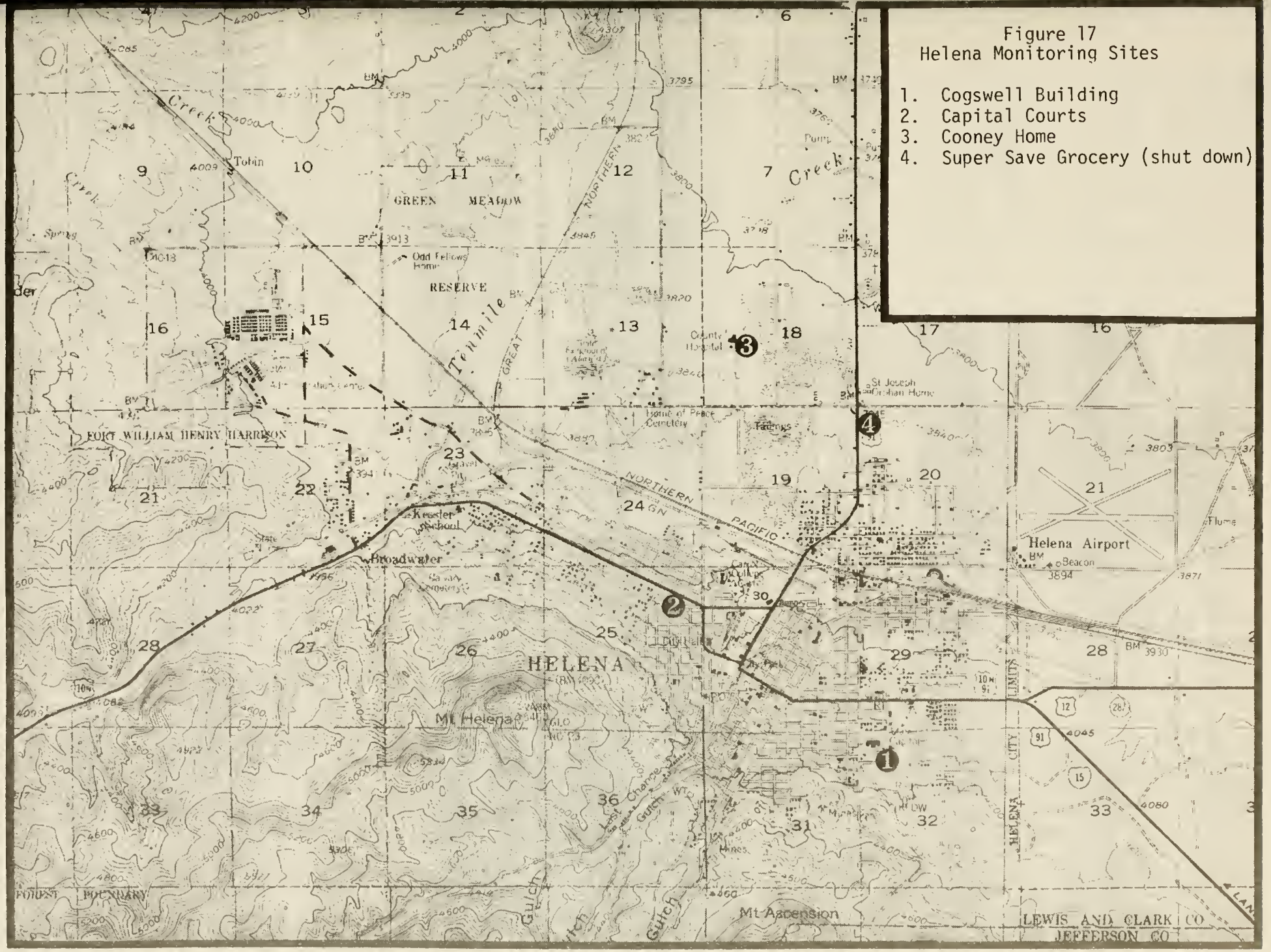


Figure 17
Helena Monitoring Sites
1. Cogswell Building
2. Capital Courts
3. Cooney Home
4. Super Save Grocery (shut down)
HELENA
Mt Helena
Mt Ascension
Broadwater
Helena Airport
GREEN MEADOW
RESERVE
FORT WILLIAM HENRY HARRISON
NORTHERN PACIFIC
LEWIS AND CLARK CO
JEFFERSON CO

Despite the poor correlations, the results of the t-test (P=0.326) indicate that the differences in the means for data from the Cogswell Building and Capital Courts sites are not significant. These results are inconclusive considering the large standard deviation of the differences.

Due to a long historical record at this site, its convenient location, and the fact that it is apparently monitoring different emission sources, the AQB recommends that sampling continue at this location.

7. The Capital Courts site is operated by the Lewis and Clark County Health Department and is located downwind of a residential area and upwind of a commercial strip.

   TSP levels at this site correlated poorly with the Cogswell Building site (R=0.4289) and well with the Super Save Grocery site (R=0.7151). As mentioned earlier, the elevational difference between the Cogswell Building and the Capital Courts site may be the main cause of the poor correlation. On the other hand, the good correlation with the Super Save Grocery indicates that both sites have similar meteorological regimes and are sampling similar emissions.

   The Lewis and Clark County Health Department will continue to operate this site in order to monitor TSP on the west side of Helena.

8. The Super Save Grocery site was moved approximately 0.75 miles west to the roof of the Cooney Rest Home. Although readings were relatively high at the Super Save Grocery site, the Lewis and Clark County Health Department decided to move the site because of extremely poor access to the roof.

   The new site at the Cooney Home is at a similar elevation and in the same geographical area of town. However, the high density commercial

development near the Super Save Grocery is absent at the new site. The Cooney Home site started operating in November of 1982.

The Lewis and Clark County Health Department intends to operate this site for at least one calendar year.

East Helena

1. East Helena is a small community about five miles east of Helena and is the site of the ASARCo lead smelter. East Helena has recently experienced residential growth along its southern and eastern edges.
2. During late 1980 and early 1981, the AQB in cooperation with the ASARCo lead smelter, operated eleven high volume samplers in the vicinity of East Helena. The major purpose of the monitors was to quantify ambient lead concentrations. At the conclusion of the study the AQB chose to continue to operate the Dartman, Hadfield, Hastie, South and Montana City sites. The decision was based on the high lead concentrations at the Dartman, Hadfield, Hastie and South sites as well as the relatively high TSP levels at the Hadfield, Hastie and Montana City sites. The sites which remained did not begin routine operation (six day cycle) until June of 1982, due to a special sampling schedule associated with the East Helena lead SIP.
3. Since none of the East Helena sites recorded a complete set of data for both 1981 and 1982, it is very difficult to determine any trends. For those sites that had TSP data in each year, concentrations either remained constant or went down. The reductions varied from 24 percent at the Hadfield site to no change at the Montana City site.
4. None of the sites had sufficient data to determine a valid annual average for 1982. The Montana City School site was the only East Helena area site which exceeded the federal 24-hour secondary standard. The

monitor recorded maximum 24-hour particulate concentrations of 188 ug/m^3 and 182 ug/m^3.

5. Tables 14 and 15 summarize the results of the statistical analyses performed on the East Helena TSP data. The Montana City site was not included in the statistical analyses, since it is geographically removed from the other sites. Figure 18 shows the locations of the monitoring sites.

6. The Hastie site is situated in East Helena just across Highway 12 and Pacific Street from American Chemet and the ASARCo smelter. During the last half of 1982, the geometric mean was 56 ug/m^3.

   TSP levels from the Hastie site correlated well with the South (R=0.7664) and Hadfield (R=0.7895) sites and very well with the Dartman (R=0.8160) site. The AQB believes that all four sites are being influenced by fugitive emissions from city streets and parking lots and from the ASARCo smelter and American Chemet.

TABLE 14

CORRELATION COEFFICIENTS OF TOTAL SUSPENDED PARTICULATE DATA FROM EAST HELENA MONITORING SITES

	Hastie Residence	South	Hadfield	Dartman
Hastie Residence	--	0.7664 (20) P=0.000	0.7895 (20) P=0.000	0.8160 (23) P=0.000
South	0.7664 (20) P=0.000	--	0.5935 (21) P=0.002	0.6685 (26) P=0.000
Hadfield	0.7895 (20) P=0.000	0.5935 (21) P=0.002	--	0.8856 (25) P=0.000

Note: 0.7664 = correlation coefficient
(20) = number of data pairs
P=0.000=one tailed probability

TABLE 15

T-TEST RESULTS OF THE COMPARISON OF TOTAL SUSPENDED PARTICULATE DATA FROM EAST HELENA MONITORING SITES

	Hastie Residence	South	Hadfield	Dartman
Hastie Residence	--	19.2500 16.189 5.32 P=0.000	-10.6000 19.343 - 2.45 P=0.024	-11.8261 19.102 - 2.97 P=0.007
South		--	-30.2857 23.852 - 5.82 P=0.000	-33.6154 21.665 - 7.91 P=0.000
Hadfield			--	- 4.0400 14.337 - 1.41 P=0.172

Note: 19.2500= mean of the differences
16.189 = standard deviation of the differences
5.32 = t-value
P=0.000= two tailed probability

The results of the t-tests indicate that although the sites correlated well, the data sets have means which are statistically different at the 95 percent confidence level.

The AQB will continue to operate the Hastie site for at least three additional years, due to the site's historical significance and the need to track TSP and lead concentrations in conjunction with the TSP non-attainment status and the East Helena lead State Implementation Plan.

7. The Hadfield site is located just south of the Main Street of East Helena. The Hadfield site registered the highest geometric mean for TSP (61 ug/m^3) of any of the East Helena sites except for the Montana City site. Of course, like all the East Helena sites, it only operated during the last half of the year.

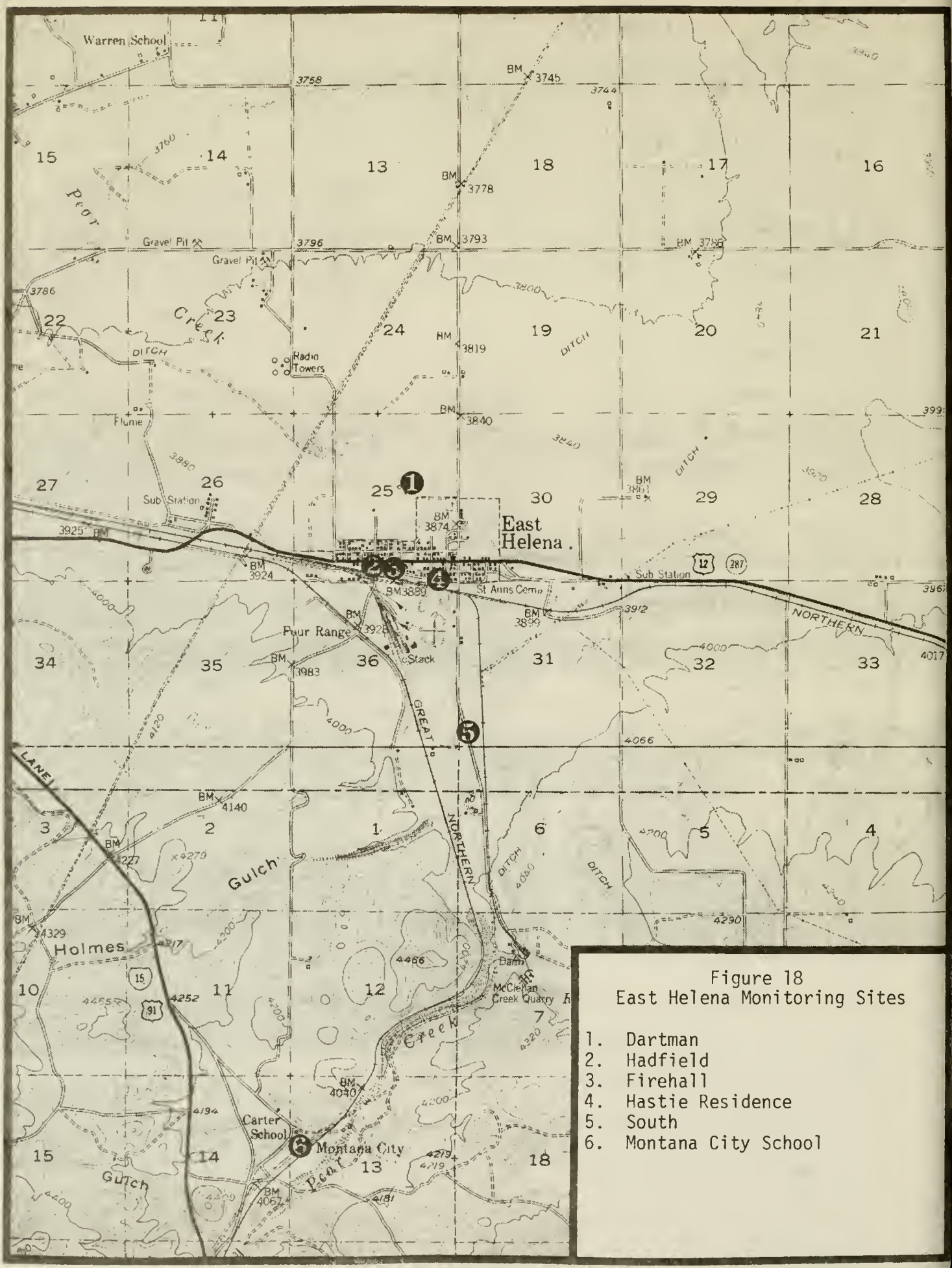


Figure 18
East Helena Monitoring Sites

1. Dartman
2. Hadfield
3. Firehall
4. Hastie Residence
5. South
6. Montana City School

Particulate levels at the Hadfield site correlated poorly with the South site (R=0.5935), fairly well with the Hastie site (R=0.7895) and very well with Dartman site (R=0.8856). The results of the t-test indicated that the TSP mean at the Hadfield site was statistically different from the means at the Hastie and South sites. However, the hypothesis that the Hadfield and Dartman TSP mean are equal could not be rejected. The AQB suggests that these two are monitoring similar emissions but with somewhat different source strengths.

The AQB will continue to operate the Hadfield site for at least three more years to track the progress of the East Helena lead State Implementation Plan.

8. The South site is located in a field approximately .75 miles south southeast of the ASARCo smelter. The predominant land use in the area is agriculture, although much of the land is unused open space. The site is operated primarily to determine lead concentrations resulting from the ASARCO main stack and plant fugitives. Of course, TSP concentrations are an added benefit.

   TSP levels at the South site correlated poorly with the Hadfield site (R=0.5935), fair with the Dartman site (R=0.6685), and well with the Hastie site (R=0.7895). It is interesting that the correlations become better moving from the Hadfield site clockwise toward the South site. The t-test indicates that the mean for the South site is significantly different from the means of all other sites.

   The AQB intends to continue monitoring at the South site for at least three additional years.

9. The Dartman site is located in a field just north of East Helena. TSP levels are quite low; however lead levels are high.

   Although the site had to be moved a short distance due to farming activity, the AQB intends to operate the Dartman site in order to track lead concentrations in conjunction with the East Helena SIP.

10. The AQB operated a high volume sampler at the East Helena Firehall for four months during 1981. During that period high lead concentrations were recorded. Therefore, the AQB with cooperation from ASARCo intends to reopen a site at this location during the summer of 1983 and monitor TSP and metals.

11. The Montana City high volume sampler was installed on the roof of the Montana City School in February of 1982. Sampling was initiated in response to several complaints from residents of the area and due to some high TSP levels recorded during a short-term lead study in early 1981. The site is located approximately 0.3 miles west southwest of the Kaiser Cement plant and near the intersection of secondary highway 518 and the Saddle Mountain Road. The Saddle Mountain Road is unpaved except for the first 200 yards near the school which were chip sealed during the summer of 1983. The road has an average daily traffic of between 500-600 cars. Figure 18 shows the location of the Montana City School site.

Anaconda

1. Anaconda is a city of approximately 10,000 people situated at the south end of the Deerlodge Valley. With the closure of the Anaconda Company smelter in 1980, the population of Anaconda has decreased and is expected to continue to decline. The AQB anticipates that particulate emissions will go down with the population trend.

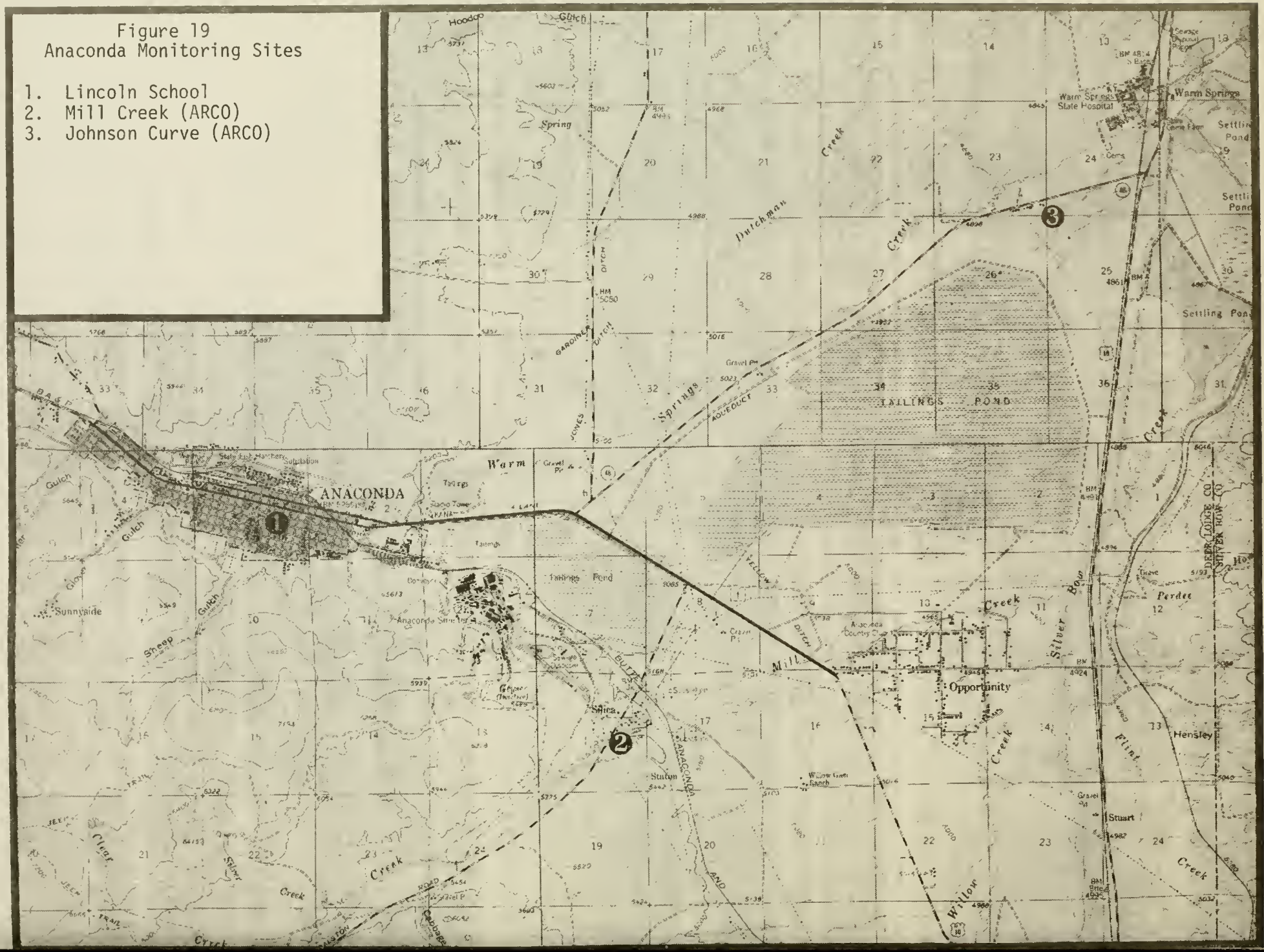
2. The Lincoln School monitoring site is located in an older residential area near the center of the city. Over the past three years TSP levels have steadily declined to a very low annual average concentration of 35 ug/m^3 in 1982.
3. Despite low TSP readings, the AQB plans to continue to operate a high volume sampler at the Lincoln School site. The primary purpose of the site is to track the decay of ambient lead concentrations as a result of the smelter closure and to monitor air quality impacts of the demolition of the smelter.
4. The Anaconda Company will continue to operate high volume samplers and inhalable particulate samplers at the Lincoln School, Mill Creek, and Johnson Curve sites. The Anaconda Company will be performing chemical analysis on these filters to track the demolition of the smelter and the maintenance of the tailings ponds.
5. The locations of the monitors are shown on Figure 19 and Table 24 summarizes the Lincoln School TSP data.

Butte

1. The City of Butte is situated on the north end of the summit valley (5400 MSL) and extends up the north hill to the city of Walkerville. In June of 1983 the Anaconda Minerals Company shut down their Berkeley pit copper mine and in July of 1983 they closed the Weed Concentrator. The Anaconda Company considers the shutdown as a temporary closure.

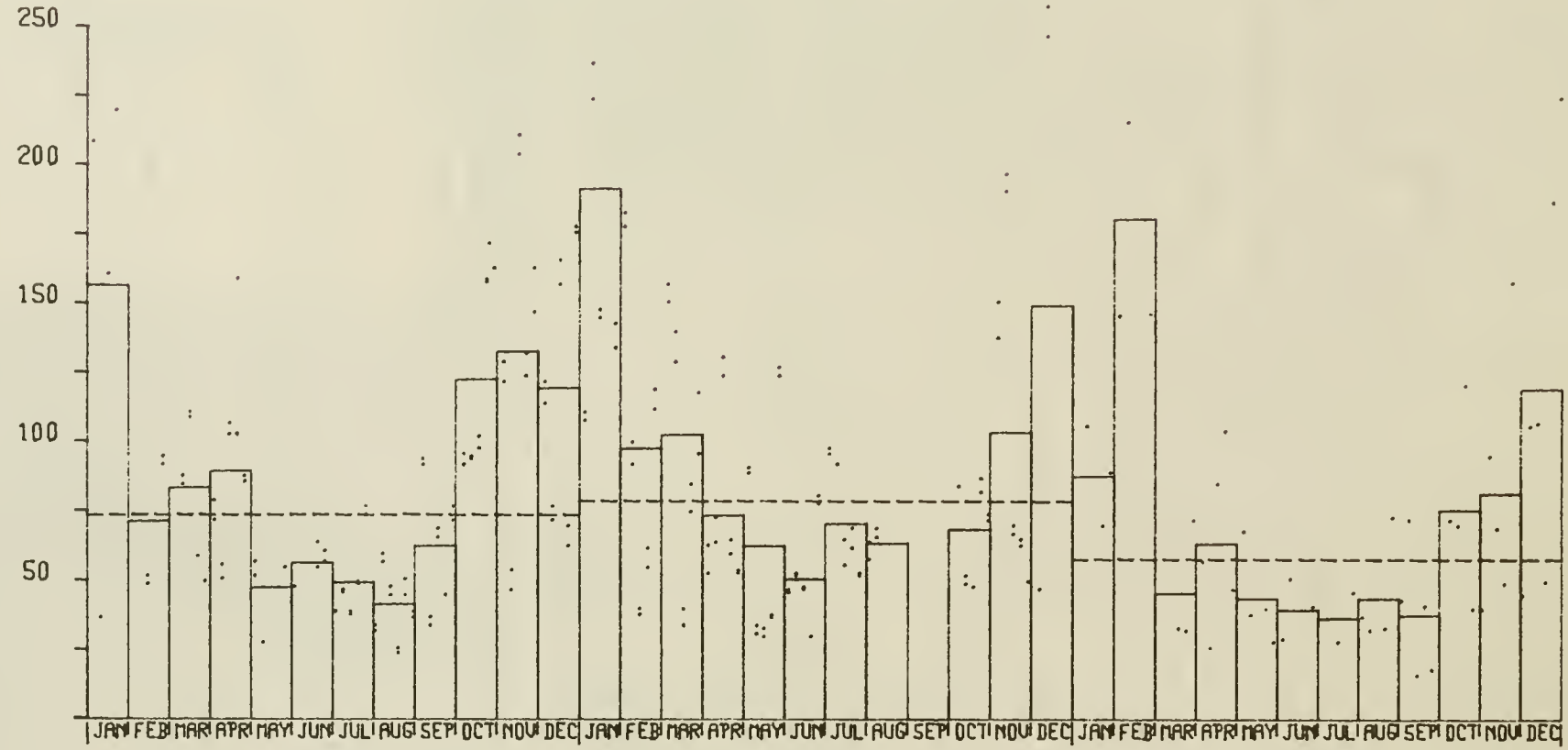
Figure 19
Anaconda Monitoring Sites

1. Lincoln School
2. Mill Creek (ARCO)
3. Johnson Curve (ARCO)



2. All four Butte particulate sites registered lower TSP levels in 1982. The Blaine School monitor led the way with a 30 percent decline while the Greeley School, Hebgen Park and Dr. Canty sites were close behind with decreases of 28, 27 and 24 percent respectively. The AQB suspects that the reduction was caused by better than average atmospheric dispersion conditions in 1982 as well as a general slowdown in economic activity including the Berkeley Pit. With the closure of the mine and concentrator and predicted loss in population, the Air Quality Bureau expects particulate levels to continue to go down. Figure 20 displays the TSP trend for the past three years at the Greeley School.
3. In 1982 none of the TSP sites recorded violations of any of the federal primary standards. However, the Hebgen Park and Greeley School sites did exceed the federal secondary 24-hour standard. The Montana 24-hour standard was also violated at the Greeley School monitor.
4. Tables 16 and 17 show the results of the statistical analyses performed on the Butte TSP data. Figure 21 displays the monthly patterns of Butte particulate concentrations while Figure 22 is a map of Butte showing the locations of the monitoring sites.
5. Many of the conclusions contained in the 1981 and 1982 Network Review are still pertinent, and therefore the Air Quality Bureau has summarized them below:
    a. Butte TSP concentrations decreased with site elevation;
    b. Summer to winter variations are less pronounced as site elevation increases;
    c. Since 1977 all 24-hour TSP concentrations at the Greeley School greater than 150 ug/m^3 occurred during the months of October through March;

Figure 20


250
200
150
100
50
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC
1980
1981
1982

NUM OBS	4	4	6	10	4	5	10	12	10	10	10	10	10	10	10	10	10	10	9	4		8	10	4	3	2	3	5	4	3	2	4	5	4	5	6
MO.AVG	157	72	84	90	48	57	50	42	63	123	133	120	192	98	103	74	63	51	71	64		69	104	150	88	181	46	64	44	40	37	44	38	76	82	120
GEO.AVG	74												79												58											

PLOT. . . . . CONCENTRATION VERSUS TIME
METHOD . . . . . HI VOL
UNITS . . . . . MICROGRAMS/CUBIC METER
STANDARDS . . . (FEDERAL) ANNUAL - 75 UG/CU.M

PARAMETER . . TOTAL SUSPENDED PARTICULATES
AREA. . . . . 0160, SILVER BOW CO
SITE. . . . . 005, GREELEY SCHOOL
CITY. . . . . BUTTE

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TABLE 16

CORRELATION COEFFICIENTS OF TOTAL SUSPENDED PARTICULATE DATA FROM BUTTE MONITORING SITES

	Hebgen Park	Dr. Canty	Blaine School	Greeley School
Hebgen Park	---	0.9207 (52) P=0.000	0.3791 (29) P=0.021	0.9708 (41) P=0.000
Dr. Canty	0.9207 (52) P=0.000	---	0.5410 (32) P=0.001	0.8905 (46) P=0.000
Blaine School	0.3791 (29) P=0.021	0.5410 (32) P=0.001	---	0.3308 (23) P=0.062

Note: 0.9207 = correlation coefficient
(52) = number of data pairs
P=0.000 = one tailed probability

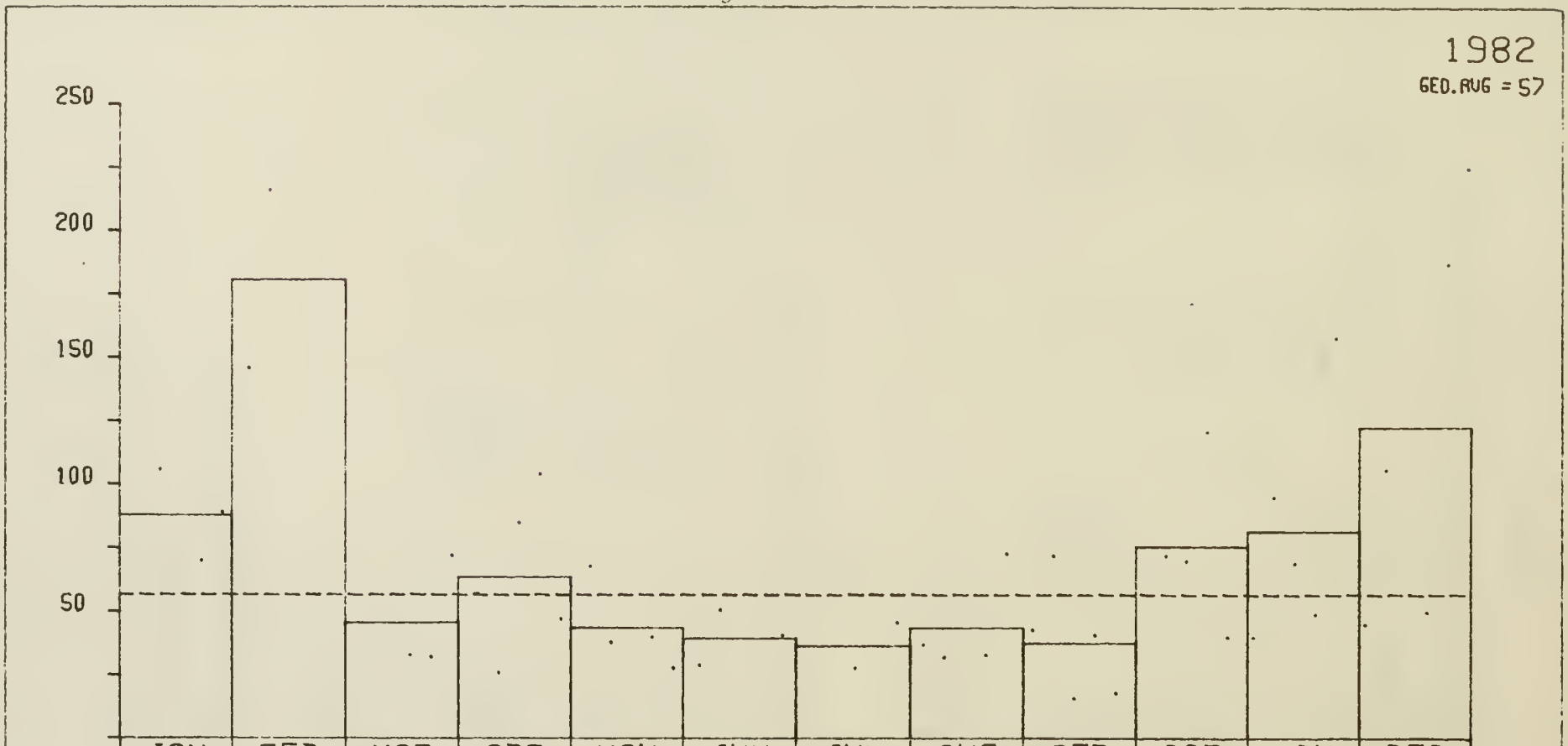
TABLE 17

T-TEST RESULTS OF THE COMPARISON OF TOTAL SUSPENDED PARTICULATE DATA FROM BUTTE MONITORING SITES

	Greeley School	Blaine School	Dr. Canty
Hebgen Park	- 7.9512 12.950 - 3.93 P=0.000	25.3793 26.496 5.16 P=0.000	15.5769 15.552 7.22 P=0.000
Dr. Canty	-24.4565 25.285 - 6.56 P=0.000	20.6875 25.809 4.53 P=0.000	---
Blaine School	-38.1739 44.023 - 4.16 P=0.000		

Note: - 7.9512 = mean of the difference
12.950 = standard deviation of the differences
- 3.93 = t value
P=0.000 = two tailed probability

Figure 21



	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
NUM-OBS	3	2	3	5	4	3	2	4	5	4	5	5
1-HIGH	106	216	72	104	68	51	46	73	72	121	158	225
2-HIGH	89	146	33	85	40	41	28	37	43	72	95	187
MO.AVG	88	181	46	64	44	40	37	44	38	76	82	123

PLOT. . . . . CONCENTRATION VERSUS TIME
METHOD . . . . . HI VOL
UNITS . . . . . MICROGRAMS/CUBIC METER
STANDARDS . . . (FEDERAL) ANNUAL - 75 UG/CU.M

PARAMETER . . TOTAL SUSPENDED PARTICULATES
AREA. . . . . 0160, SILVER BOW CO
SITE. . . . . 005, GREELEY SCHOOL
CITY. . . . . BUTTE

MONTANA STATE AIR QUALITY BUREAU

APRIL 1983

TECHNICAL SERVICES

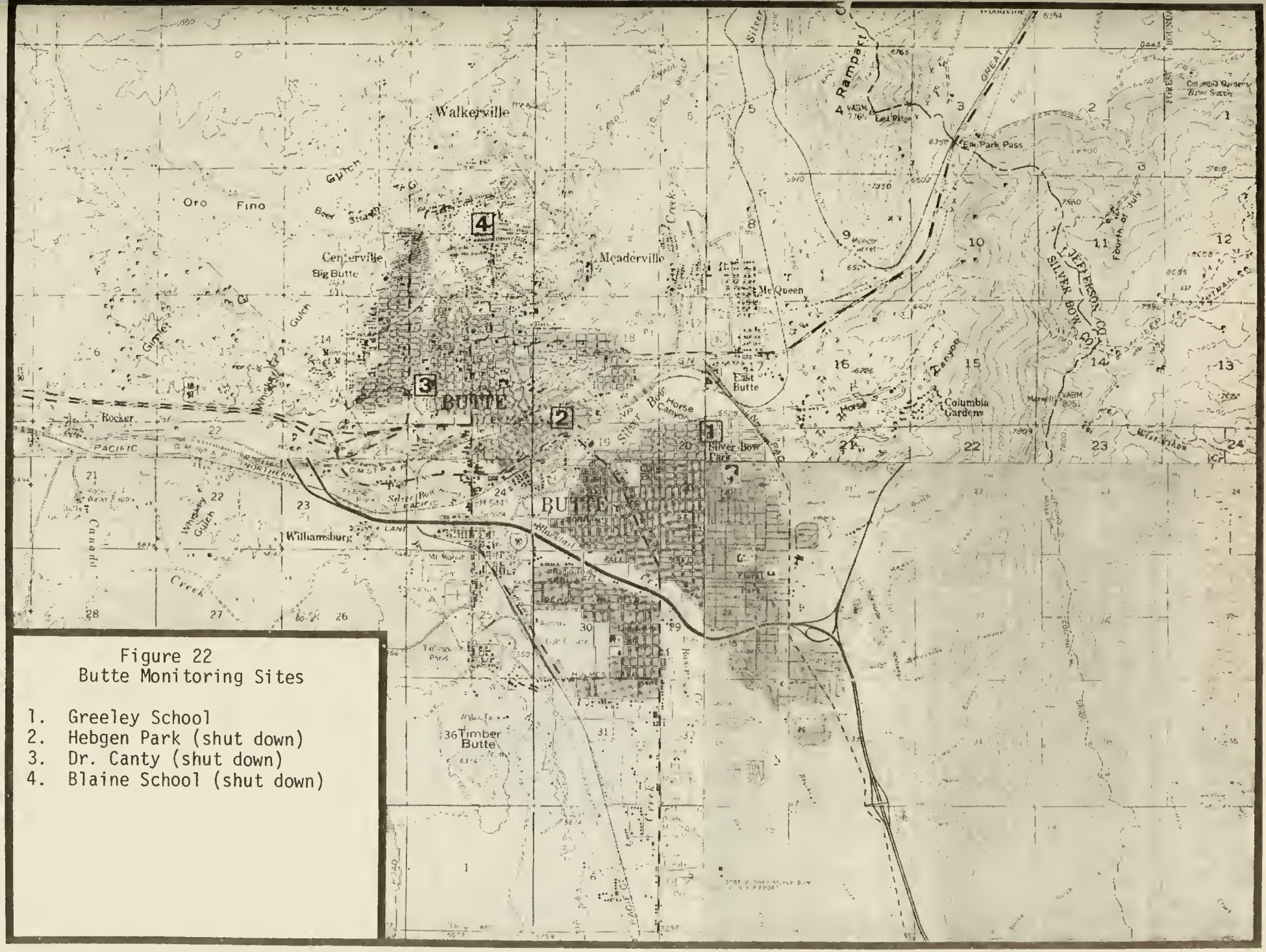


Figure 22
Butte Monitoring Sites

1. Greeley School
2. Hebgen Park (shut down)
3. Dr. Canty (shut down)
4. Blaine School (shut down)

d. Although winter is when high TSP levels occur in Butte, warm winters do not appear to result in lower TSP concentrations;

e. Precipitation does not show any relationship to concentrations of TSP at the Greeley School site;

f. High TSP concentrations are associated with synoptic stagnation, clear skies, and low wind speeds;

g. Until 1980, Berkeley Pit emissions correlated well on an annual basis with Greeley School TSP readings. However, since 1980 the correlation has become less significant and it is suspected that residential wood burning is becoming a significant emission source.

6. The Greeley School site is equipped with colocated samplers and is located near the lowest point in the valley (5430 MSL). It is situated in a residential area 0.3 miles from the Anaconda Company crusher and 0.6 miles from the Berkeley Pit. The site has provided TSP data continuously since 1974.

The TSP levels at the Greeley School site are usually much higher (see Figure 21) in the winter than during the warmer months. The average concentration recorded for the winter months (October-March) was 95 ug/m^3, while the average summer concentration (April-September) was 41 ug/m^3. The higher wintertime concentrations are probably due to poor dispersion conditions at this time of year.

Particulate levels at the Greeley School site showed excellent correlation with the Hebgen Park site (R=.9708), very good correlation with the Dr. Canty site (R=0.8905) and very poor correlation with the Blaine School site (R=0.3308). The excellent correlation with the Hebgen Park data is consistent with the results of the 1981 Network

Review and indicates that the two sites are being influenced by a similar or identical emission source mix. However, the t-test indicated that the mean at Hebgen Park is statistically lower than the mean at the Greeley School.

A review of past data shows that the Greeley School concentrations have been higher than the levels at the Hebgen Park site three out of the past four years. Since the two sites are located near one another and appear to be sampling similar sources, the Air Quality Bureau recommends that one site be closed. In light of the lower TSP levels at the Hebgen Park site, the AQB shut down sampling at the Hebgen Park in June of 1983.

7. The Hebgen Park site is located in a residential area 0.5 miles southwest of the Berkeley Pit and at a slightly higher elevation than the Greeley School.

   Total suspended particulate levels at Hebgen Park correlated extremely well with the data from the Greeley School (R=0.9708) and Dr. Canty (R=0.9207) sites, and very poorly with the Blaine School (R=0.3791) site.

   As stated earlier, the AQB shut down the Hebgen Park site in June of 1983.

8. The high volume sampler located on the roof of Dr. Canty's Office is situated on the west side of Butte in a small valley separated from the downtown area and the Berkeley Pit by a small ridge. The site is approximately 230 feet higher than the Greeley School.

Since TSP concentrations correlate very well with the Greeley School site and extremely well with the Hebgen Park site, the AQB terminated sampling at this site in June of 1983. The AQB's decision to shut down this site was also influenced by the fact that TSP levels at the Dr. Canty site have consistently been lower than either the Greeley School or Hebgen Park sites and the Butte area particulate emissions are expected to continue to decline.

9. Due to consistently low readings, the Blaine School sampler was permanently shut down in October of 1982.

Bozeman

1. The city of Bozeman lies near the eastern edge of the Gallatin Valley at an elevation of 4800 feet above sea level. The Gallatin Valley is subject to frequent temperature inversions and stable atmospheric conditions. This phenomenon is accentuated by the confinement created by the surrounding mountains and a higher than average rate of radiation surface cooling caused by the city's high elevation and persistent winter snow cover.
2. TSP concentrations in Bozeman showed an overall decrease in 1982. The monitor at the East Main City Building registered the largest decrease with an 18 percent reduction, while the Traphagen Hall station remained constant at 25 ug/m^3. This downward trend is probably due to reduced economic activity and better than average atmospheric dispersion during 1982.
3. The East Main City Building monitor measured one 24-hour sample in excess of the federal 24-hour primary standard of 260 ug/m^3. Both the East Main City Building and the Whittier School sites exceeded the 24-hour federal secondary standards of 150 ug/m^3. In addition, the East Main site exceeded the federal secondary standard of 60 ug/m^3 for an annual average. Table 24 summarizes the TSP concentrations in Bozeman.
4. Figure 23 shows geographical locations of the Bozeman monitoring sites. Tables 18 and 19 describe the statistical results for the various comparisons made on the Bozeman data.
5. The East Main site is the primary sampling site in Bozeman and also recorded the highest readings. The sampler is operated through a cooperative arrangement between the AQB and the Gallatin County Health Department. The TSP data from this site displayed a very good

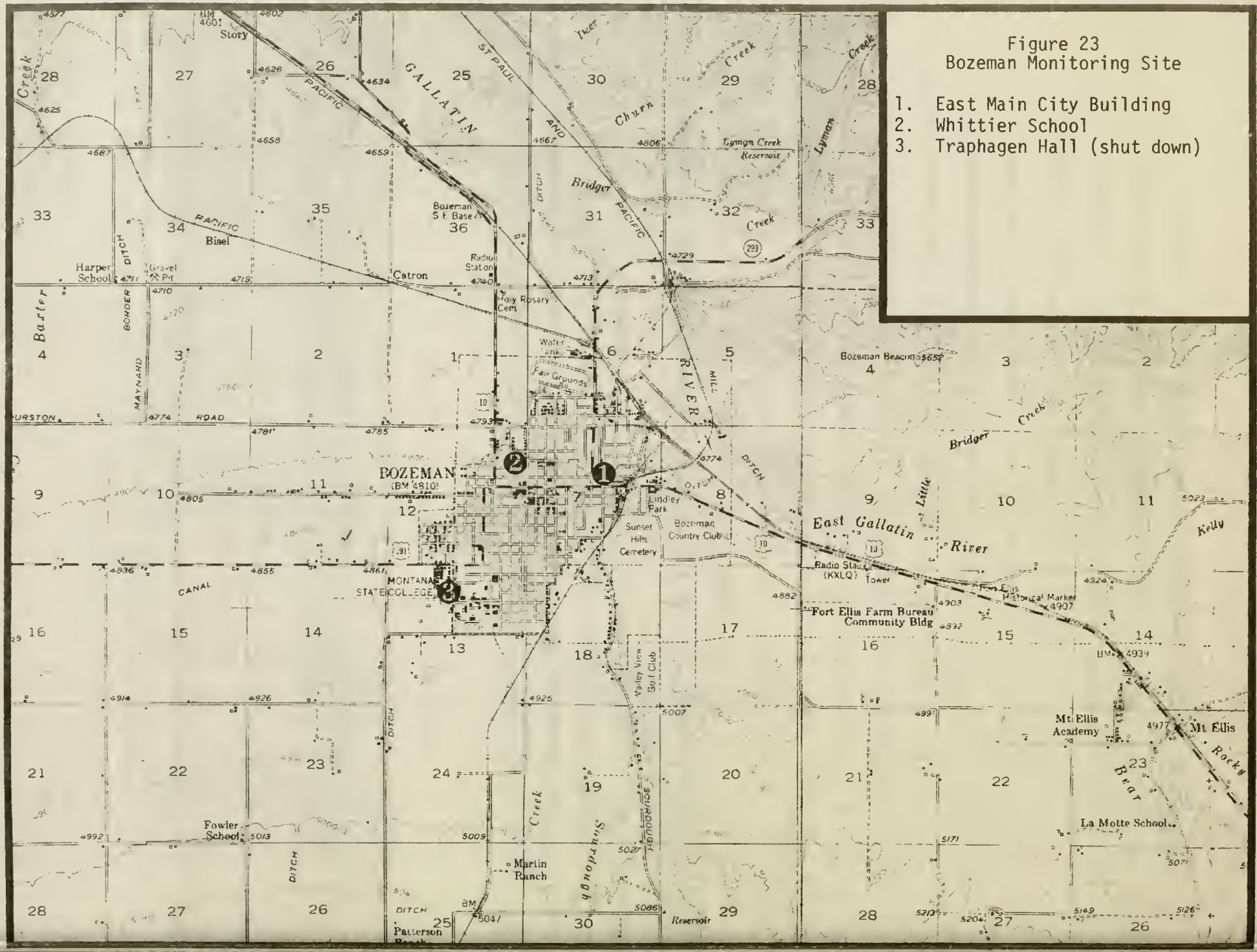


Figure 23
Bozeman Monitoring Site

1. East Main City Building
2. Whittier School
3. Traphagen Hall (shut down)

TABLE 18

CORRELATION COEFFICIENTS OF TOTAL SUSPENDED PARTICULATE DATA FROM BOZEMAN MONITORING SITES

	East Main City Building	Whittier School	Traphagen Hall
East Main City Buiing	---	0.8179 (48) P=0.000	0.5253 (26) P=0.003
Whittier School	0.8179 (48) P=0.000	---	0.3878 (32) P=0.014

Note: 0.8179 = correlation coefficients
(48) = number of data pairs
P=0.000 = one tailed probability

TABLE 19

T-TEST RESULTS OF THE COMPARISON OF TOTAL SUSPENDED PARTICULATE DATA FROM BOZEMAN MONITORING SITES

	East Main City Building	Whittier School	Traphagen Hall
East Main City Building	---	13.7292 25.809 3.69 P=0.001	-52.9231 48.960 - 5.51 P=0.000
Whittier School		---	-32.0313 28.041 - 6.46 P=0.000

Note: 13.7292 = mean of the differences
25.809 = standard deviation of the differences
3.69 = t value
P=0.001 = two tailed probability

correlation (R=0.8179) with the Whittier School site and a poor correlation (R=0.5253) with the Traphagen Hall site. The very good correlation with the Whittier School site indicates that both sites are being influenced by similar sources. However, the t-test results (P=0.0001) indicated that the two data sets are statistically different at the 95 percent confidence level.

The East Main site recorded the highest 1982 TSP readings during February, March and April (see Figure 24). The AQB suspects that the high concentrations during these months are probably due to fugitive dust off of roads, and to a lesser extent, smoke from residential wood burning.

The AQB recommends the continued operation of the East Main site.

6. The Whittier School monitor is located on the west edge of a residential area and one block east of Seventh Avenue, which is a major arterial. The AQB initiated sampling in December of 1981, therefore 1982 represented the first full year for which data was gathered.

   Data from the Whittier School site showed similar seasonal trends to that observed at the East Main site. The good correlation with the East Main site indicates that this site is also being significantly influenced by road dust.

   The AQB will operate this site in conjunction with the Gallatin County Health Department for at least one additional calendar year.

7. The Traphagen Hall site was located on top of Traphagen Hall approximately 15 meters above ground level. TSP concentrations at Traphagen Hall are generally low, probably due to its elevated location and the lack of emission sources in the campus area. The sampler was owned and operated by Montana State University, while the AQB performed the filter analysis. Due to the low concentrations registered at this site, its elevated location, and budget restraints, the AQB ceased providing free filter analysis in the middle of 1982. As a result, Montana State University terminated sampling at this site in September of 1982.

1982

GEO.AVG = 56

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
NUM-OBS	3	3	4	5	4	5	3	3	5	5	5	6
1-HIGH	64	148	265	180	76	87	86	71	97	105	55	68
2-HIGH	42	61	146	110	64	87	68	35	74	77	50	36
NO.AVG	43	81	133	105	57	63	70	47	57	74	42	32

PLOT. . . . . CONCENTRATION VERSUS TIME

METHOD . . . . . HI VOL

UNITS . . . . . MICROGRAMS/CUBIC METER

STANDARDS . . . (FEDERAL) ANNUAL - 75 UG/CU.M

PARAMETER . . TOTAL SUSPENDED PARTICULATES

AREA. . . . . 0120, GALLATIN CO

SITE. . . . . 002, EAST MAIN CITY BLDG

CITY. . . . . BOZEMAN

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Proposed New Sites

Most of southwestern Montana lies just east of the Continental Divide and is characterized by mountain ranges and broad valleys. The Bureau intends to develop a TSP data base for all southwestern Montana cities with a population of over 3,000 people. Dillon, with a population of 4550, is the only city which falls into this category. Figure 25 is a map of Dillon showing the proposed location of the sampler.

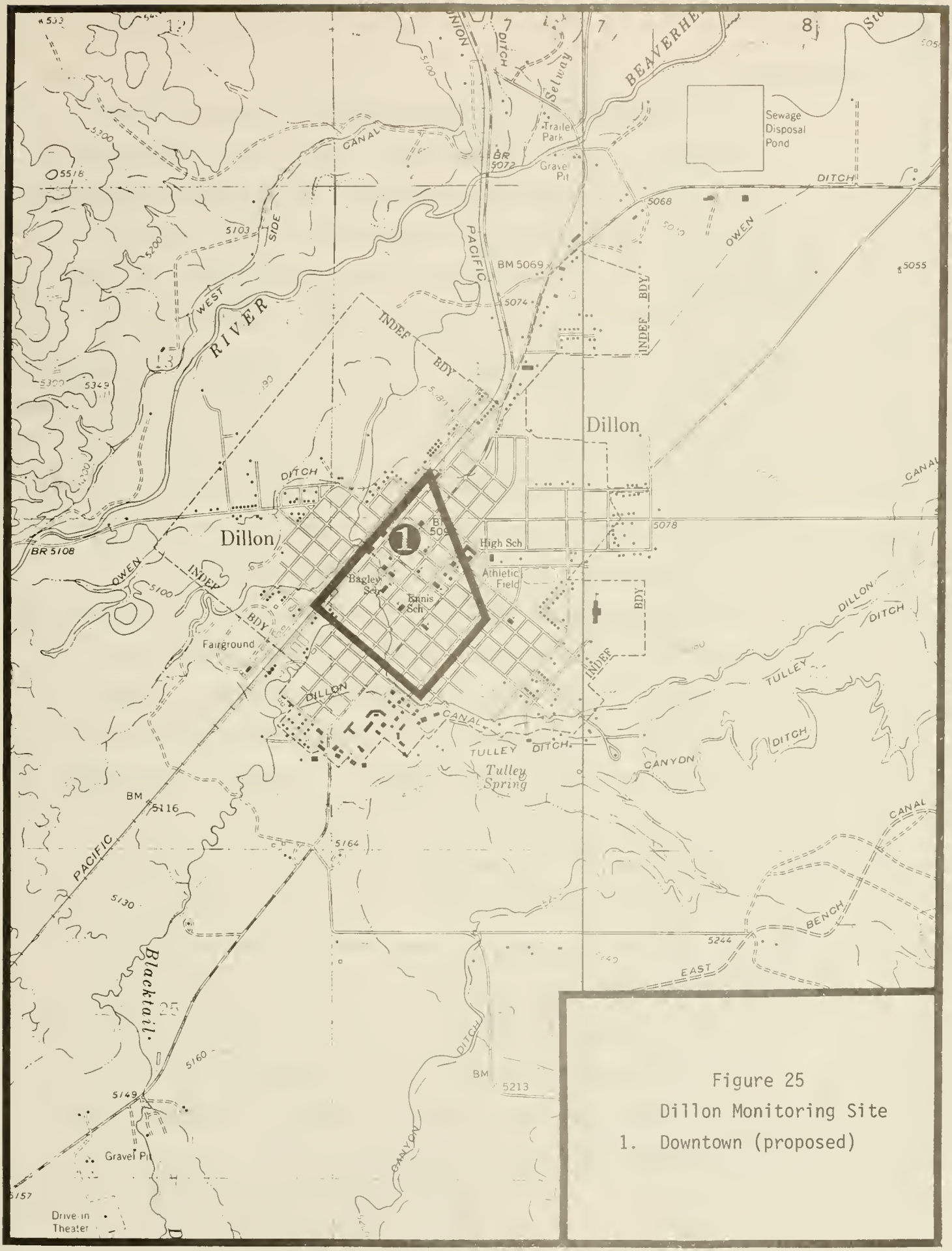
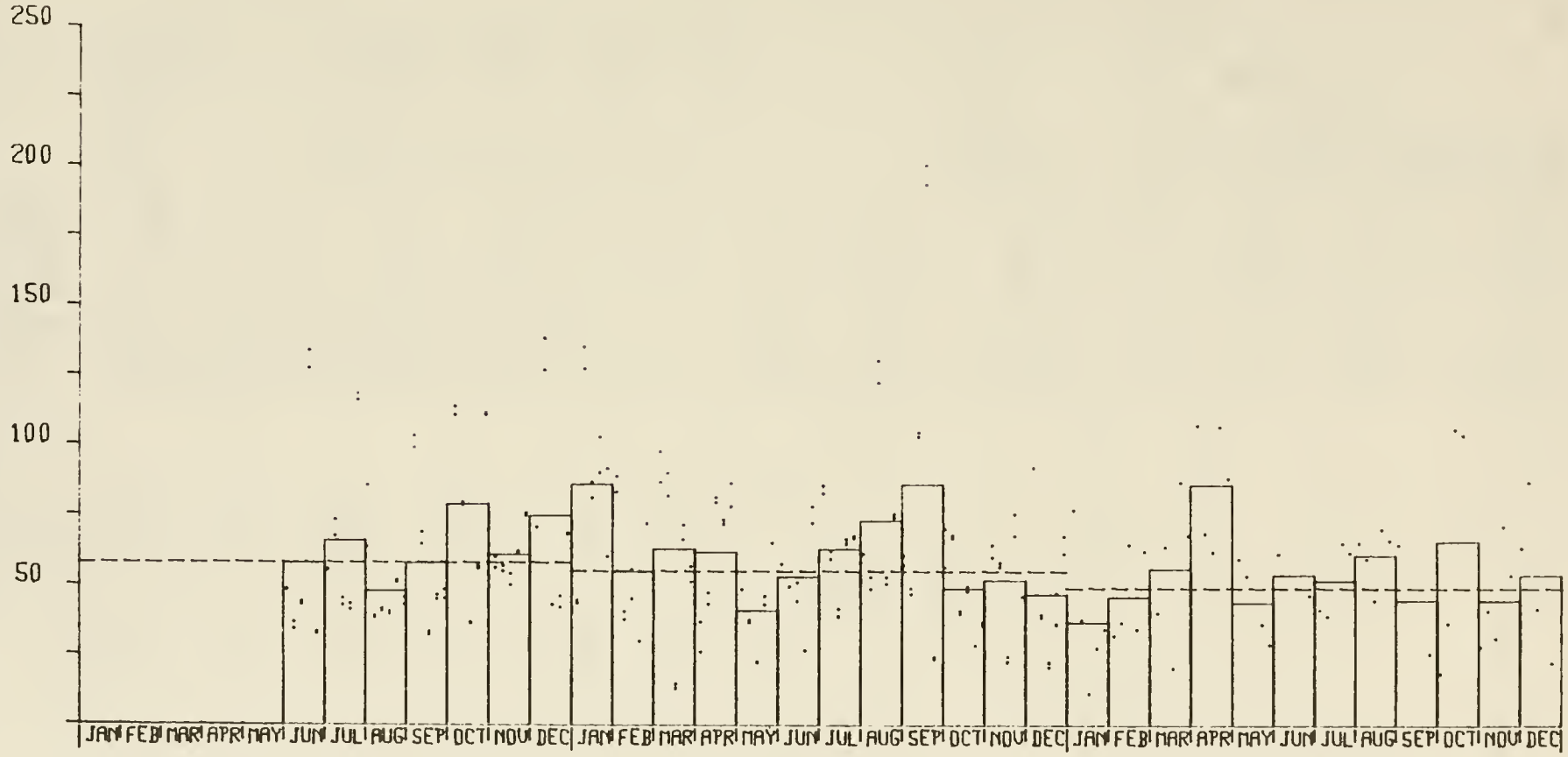


Figure 25
Dillon Monitoring Site
1. Downtown (proposed)

Great Falls

1. The city of Great Falls lies along the banks of the Missouri River near the western edge of the Northern Great Plains. High concentrations of air pollutants are uncommon in Great Falls due to persistent high winds.
2. In 1982, TSP concentrations decreased at all the Great Falls sites except Black Eagle, which recorded a 10 percent increase. TSP levels at the Fire Station, Downtown, Riverview School, Lincoln School, and Kiwanis Park sites decreased 3, 11, 11, 8 and 10 percent respectively. The citywide reduction in particulate levels followed a similar decrease in 1981. Figure 26 graphically describes the downward trend for the Downtown site. The AQB suspects that the downward trend is the result of reduced industrial and commercial activity due to the recession as well as an unusually good year for atmospheric dispersion.
3. In 1982 particulate levels at the Fire Station and the Black Eagle sites exceeded the federal secondary standard for annual geometric mean. The Fire Station also exceeded the 24-hour federal secondary standard for TSP. None of the other Great Falls monitors registered violations of any Montana or federal ambient standards. A summary of the 1981 and 1982 TSP levels in Great Falls is contained in Table 24.
4. The AQB plotted 1982 monthly means for TSP for the Black Eagle, Downtown, and Fire Station sites. The Black Eagle plot is shown on Figure 27. The plots for all three sites indicated a period of high TSP during March and April, while the Fire Station site also showed a peak during August, September, and October. The increase in particulate levels during the spring are most likely caused by road dust after spring breakup. The AQB is unable to explain the late summer and early fall increase at the Fire Station monitor.



NUM OBS						10	10	12	10	10	10	8	10	10	10	10	9	8	10	10	10	11	10	9	5	5	5	5	4	2	4	5	2	4	5	4
MO.AVG						58	66	48	58	79	61	75	86	55	63	62	41	53	63	73	86	49	52	47	37	46	56	86	44	54	52	61	45	66	45	54
GEO.AVG						58							55												49											

PLOT. . . . . CONCENTRATION VERSUS TIME
METHOD . . . . . HI VOL
UNITS . . . . . MICROGRAMS/CUBIC METER
STANDARDS . . . (FEDERAL) ANNUAL - 75 UG/CU.M

PARAMETER . . TOTAL SUSPENDED PARTICULATES
AREA. . . . . 0660, CASCADE CO
SITE. . . . . 017, DOWNTOWN
CITY. . . . . GREAT FALLS

MONTANA STATE AIR QUALITY BUREAU

APRIL 1983

TECHNICAL SERVICES

Figure 27

1982

GED.AVG = 66

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
NUM-OBS	5	5	5	5	5	5	5	5	4	5	5	6
1-HIGH	88	105	144	216	102	98	140	102	84	112	75	105
2-HIGH	32	62	134	138	73	83	76	86	71	88	69	104
MO.AVG	42	60	92	128	65	75	79	77	60	74	62	66

PLOT. . . . . CONCENTRATION VERSUS TIME

METHOD . . . . . HI VOL

UNITS . . . . . MICROGRAMS/CUBIC METER

STANDARDS . . . (FEDERAL) ANNUAL - 75 UG/CU.M

PARAMETER . . TOTAL SUSPENDED PARTICULATES

AREA. . . . . 0660, CASCADE CO

SITE. . . . . 019, BLACK EAGLE

CITY. . . . . GREAT FALLS

MONTANA STATE AIR QUALITY BUREAU

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5. Tables 20 and 21 describe the results of the statistical analyses performed on the Great Falls data. Figure 28 shows the locations of each site.

6. The Fire Station site is located on the southern edge of the downtown central business district. Due to prevailing southwest winds, this site can generally be thought of as upwind of the central business district.

   The TSP values at the Fire Station correlated poorly with the Lincoln School (R=0.5517), Kiwanis Park (R=0.4943), and Riverview School (R=0.4753) sites; fairly well with the Black Eagle site (R=0.6478), and well with the Downtown site (R=0.7867).

TABLE 20

CORRELATION COEFFICIENTS OF TOTAL SUSPENDED PARTICULATE DATA FROM GREAT FALLS MONITORING SITES

	Downtown	Black Eagle	Fire Station	Lincoln School	Kiwanis Park	Riverview School
Downtown	--	0.7315 (50) P=0.000	0.7867 (44) P=0.000	0.6820 (38) P=0.000	0.6045 (35) P=0.000	0.5632 (34) P=0.000
Black Eagle	0.7315 (50) P=0.000	--	0.6478 (51) P=0.000	0.8278 (43) P=0.000	0.5999 (41) P=0.000	0.3482 (39) P=0.015
Fire Station	0.7867 (44) P=0.000	0.6478 (51) P=0.000	---	0.5517 (38) P=0.000	0.4943 (35) P=0.001	0.4753 (35) P=0.002
Lincoln School	0.6820 (38) P=0.000	0.8278 (43) P=0.000	0.5517 (38) P=0.000	--	0.8725 (39) P=0.000	0.4593 (38) P=0.002
Kiwanis Park	0.6045 (35) P=0.000	0.5999 (41) P=0.000	0.4943 (35) P=0.001	0.8725 (39) P=0.000	---	0.5982 (36) P=0.000
Riverview School	0.5632 (34) P=0.000	0.3482 (39) P=0.015	0.4753 (35) P=0.002	0.4593 (38) P=0.002	0.5982 (36) P=0.000	---

Note: 0.7315 = correlation coefficient
(50) = number of data pairs
P=0.000 = one tailed probability

TABLE 21

T-TEST RESULTS OF THE COMPARISON OF
TOTAL SUSPENDED PARTICULATE DATA FROM
GREAT FALLS MONITORING SITES

	Downtown	Black Eagle	Fire Station	Lincoln School	Kiwanis Park	Riverview School
Downtown	---	-20.654 25.356 - 5.76 P=0.000	23.2136 26.769 5.75 P=0.000	4.9921 18.911 1.63 P=0.112	-10.9714 18.157 - 3.57 P=0.001	8.6118 23.265 2.16 P=0.038
Black Eagle		---	4.3490 30.568 1.02 P=0.314	25.6163 23.772 7.07 P=0.000	-29.5073 24.915 - 7.58 P=0.000	-31.3692 38.942 - 5.03 P=0.000
Fire Station			---	28.2974 35.231 4.95 P=0.000	32.0057 36.108 5.24 P=0.000	27.3514 37.046 4.37 P=0.000
Lincoln School				---	- 5.7641 10.241 - 3.51 P=0.001	- 4.4842 25.681 - 1.08 P=0.289
Kiwanis Park					---	- 4.1194 20.600 - 1.20 P=0.238

Note: -20.6450 = mean of the differences
25.356 = standard deviation of the differences
- 5.76 = t value
P=0.000 = two tailed probability

The good correlation with the Downtown site would appear to indicate that both are monitoring the same emission source; presumably road dust from downtown traffic. Although this conclusion appears to be true for most of the year, the increase in TSP concentrations at the Fire Station during late summer and early fall without a corresponding increase at the Downtown site indicates that unique local sources may be affecting the monitors during this time period.

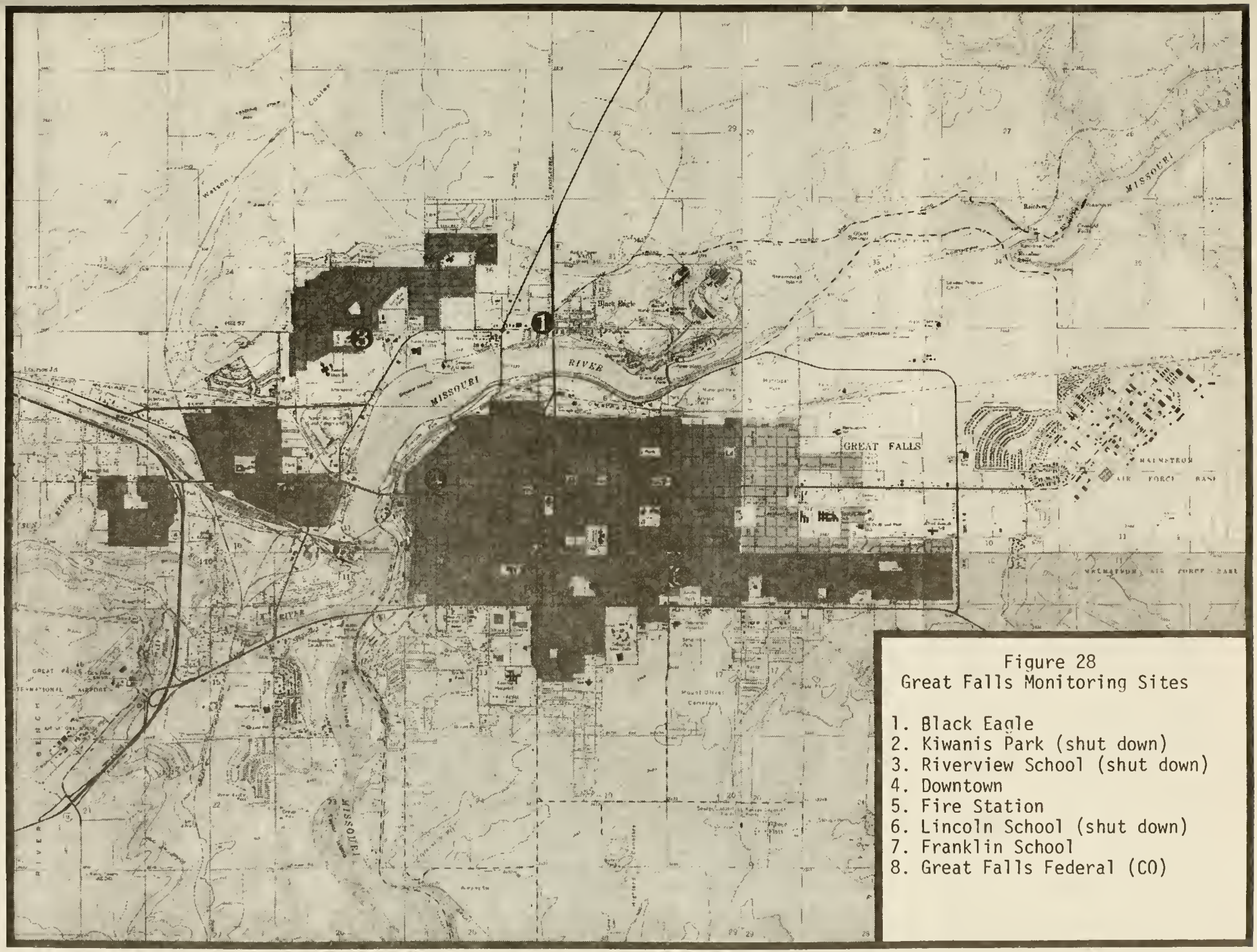


Figure 28
Great Falls Monitoring Sites

1. Black Eagle
2. Kiwanis Park (shut down)
3. Riverview School (shut down)
4. Downtown
5. Fire Station
6. Lincoln School (shut down)
7. Franklin School
8. Great Falls Federal (CO)

The substantially lower geometric mean at the Downtown site (49 ug/m^3 vs 67 ug/m^3) can be at least partially accounted for by the sampler's location 14 meters above ground level. This siting difference may also be responsible for the results of the t-test (P=0.000) which indicate that the two data sets are statistically different at the 95 percent confidence level.

The Cascade County Health Department will continue to operate a high volume sampler at this site to track particulates in the central business district of Great Falls. In light of the Downtown sampler's height above ground and relationship with the Fire Station, the site will be redesignated a SLAMS site on January 1, 1984. The Fire Station will become the Great Falls NAMS site for TSP.

7. In light of the low geometric mean (40 ug/m^3) recorded in 1981 at Kiwanis Park, the site was shut down in October of 1982. During the first nine months of 1982 the geometric mean remained low at 39 ug/m^3.
8. The Black Eagle station is located north of the Missouri River in a predominately industrial area. The Simmons Petroleum Refinery is located 0.5 miles to the west and the closed ARCO copper refinery is situated 1.0 miles to the east. The area appears to have an abundance of poorly maintained roads and a lack of vegetative cover. During 1982, various demolition activities, including the removal of the old main stack, were completed at the ARCO refinery.

   In 1982 TSP levels at the Black Eagle site actually increased over 1981. Since the increase went against the citywide down trend, the AQB suspects the demolition activities at the ARCO refinery might be responsible.

The correlation analyses and the t-test showed conflicting results for the Great Falls sites. For example, the t-test indicated that the data from the Black Eagle site and the Fire Station site had the best probability (P=0.314) of being identical data sets. On the other hand, the correlation between these two sites was only fair.

The particulate data from the Black Eagle site correlated poorly with the Riverview School (R=0.3482) and Kiwanis Park (R=0.5999) sites, fair with the Fire Station site (0.6478), well with the Downtown Site (R-0.7315) and very well with the Lincoln School site (R=0.8278). The Downtown site and the Lincoln School site are both located at a considerable distance from the Black Eagle site and therefore it is unlikely that all three sources are being influenced by the same emission sources. However, all three sites are in the vicinity of significant fugitive dust sources which probably cause particulate levels in all three areas to go up and down together.

The results of the t-test, for the most part, indicate that the means at each site are statistically different. As mentioned earlier, the only exception would be between the Fire Station and Black Eagle, where the results (P=0.314) indicate that the hypothesis that the two means are equal cannot be rejected.

Due to the relatively high readings, the Cascade County Health Department will continue to operate the Black Eagle site for at least two more years. Two additional years of monitoring will allow the AQB to continue to track the demolition project at the ARCO copper refinery.

9. The Riverview School is located in an area characterized by a mixture of light industry, residential property and vacant lots. The geometric mean at this site remained low in 1981 (45 ug/m^3) and for the first nine

months of 1982 (40 ug/m^3). In accordance with the 1982 Network Review, the site was permanently shut down during October of 1982.

10. The Lincoln School site was located three blocks north of Tenth Avenue South; the major arterial in the south end of the city. As recommended in the 1982 Network Review, the site was removed in October of 1982. TSP concentrations for the first nine months of 1982 remained low at 44 ug/m^3.

11. The Downtown site is located just north of the central business district and appears to be monitoring downtown street dust. Particulate levels correlated well with the Black Eagle (R=0.7315) and Fire Station (R=0.7867) sites and poorly with all other sites.

    The Cascade County Health Department will continue the operation of this site to track particulate levels in the Downtown area of Great Falls. The Downtown site will be redesignated as a SLAMS site on January 1, 1984.

12. In February of 1983, the Cascade County Health Department installed a new site at the Franklin School. The site was intended to fill a data void in the southwest part of the city of Great Falls. The site will be operated until February of 1984, at which time the results will be reviewed. If the concentrations remain low, the site will be terminated. If they are high, the site will be relocated nearby to a location with better access.

Yellowstone County

Monitoring of TSP in Yellowstone County is conducted by the Yellowstone County Air Pollution Control Agency and the Air Quality Bureau. All the monitoring activities are concentrated in the Yellowstone Valley between Laurel to Lockwood. Billings is the focal point for the monitoring effort and is the largest city in Montana. The Yellowstone Valley and the parallel rimrocks create a complex meteorological regime which in many respects cause inversion conditions similar to western Montana.

Laurel

1. The Yellowstone County air pollution control agency operates a high volume sampler at the Junior High School in Laurel. The geometric mean for 1982 was 25 ug/m^3 and the highest 24-hour concentration was 107 ug/m^3. The AQB recommends this site be shut down. However, since Yellowstone County wants to continue the site, the AQB will concur.
2. The AQB operated a high volume sampler at the New Farm sulfur dioxide site east of Laurel until July of 1982. The readings were quite low (28 ug/m^3) and when the sulfur dioxide monitoring was terminated so was TSP monitoring.
3. Figure 29 displays the locations of the Laurel area monitoring sites. Table 24 summarizes the Laurel TSP data.

Billings

1. Billings is located in the bottom of the Yellowstone Valley at an elevation of 3100 feet above sea level. On the north and south edges of the valley the rimrocks rise abruptly to a height of approximately 600 feet above the valley. The Yellowstone valley is approximately ten miles

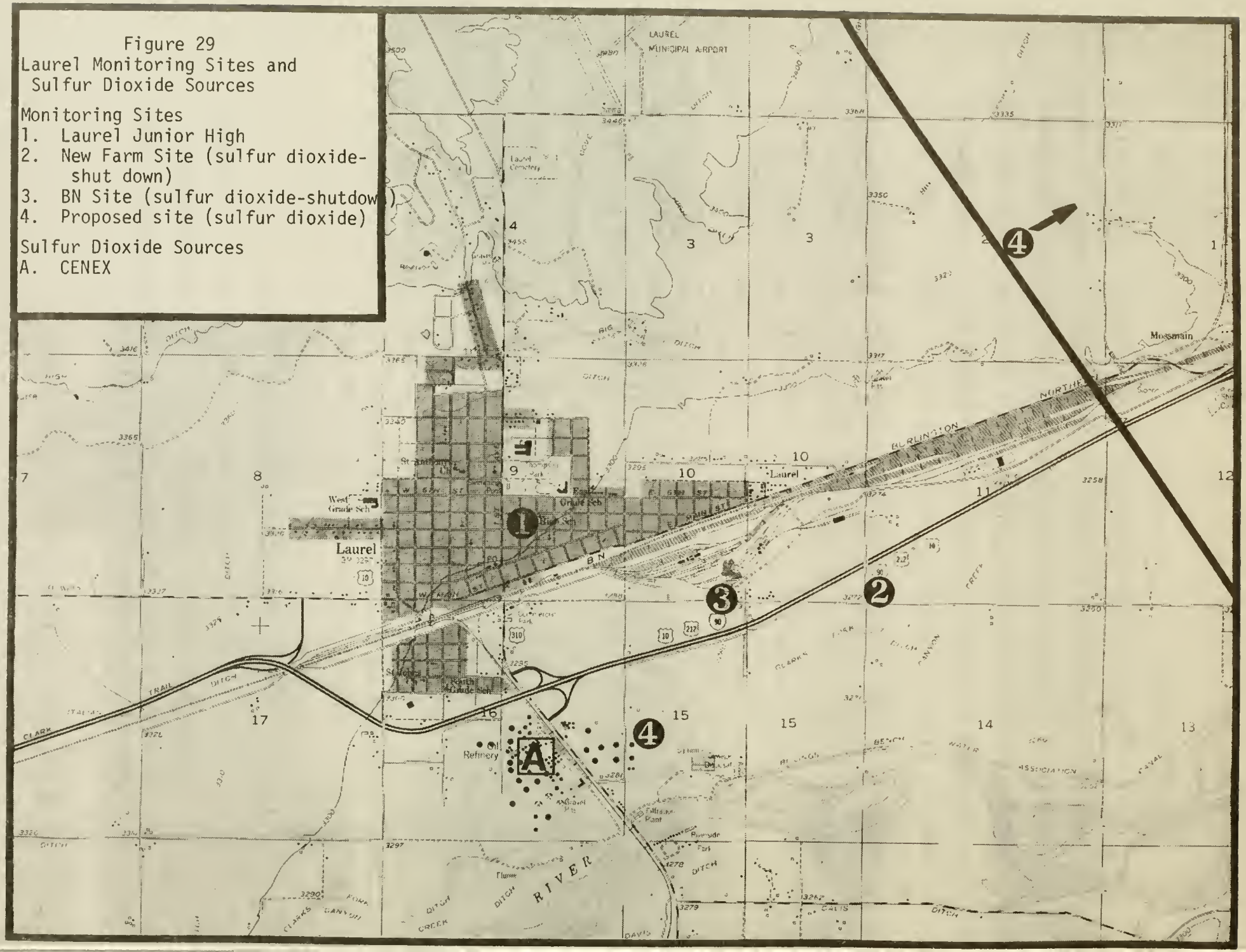


Figure 29
Laurel Monitoring Sites and
Sulfur Dioxide Sources
Monitoring Sites
1. Laurel Junior High
2. New Farm Site (sulfur dioxide-shut down)
3. BN Site (sulfur dioxide-shutdow)
4. Proposed site (sulfur dioxide)
Sulfur Dioxide Sources
A. CENEX
LAUREL MUNICIPAL AIRPORT
Laurel
Refinery
BURLINGTON NORTHE
B N
RIVER
CLARK
TRAIL
DITCH
CREEK
Mossmain

wide near Laurel (12 miles WSW of Billings) but the rimrocks form a constriction in the valley at the eastern edge of Billings. This constriction is approximately one mile wide and separates Billings from the Lockwood area.

The prevailing winds are from the southwest and are channeled down the Yellowstone valley. Although the winds are usually responsible for good atmospheric dispersion, results from the Billings sulfur dioxide study indicate that inversions are quite frequent. From September 1981 to October 1982 GeoResearch Inc. of Billings, on subcontract to Rockwell International, operated a continuous acoustic radar and launched pilot balloons equipped with temperature sondes three days per week. This meteorological data indicated that Billings is often affected by multiple layer inversions.

2. All sites in the Billings area recorded lower TSP concentrations in 1982 than in 1981. The decrease ranged from 14 percent at the City Hall site to 21 percent at the Lockwood School site.
3. All Billings TSP sites, with the exception of the Taft School site, met all state and federal ambient air quality standards during 1982. Particulate concentrations at the Taft School site exceeded the federal secondary 24-hour standard of 150 ug/m^3. Table 24 displays the geometric means and the first and second highest 24-hour concentrations for each site.
4. A summary of data for the Billings area analysis is provided in Tables 22 and 23. Table 22 displays the correlation coefficients between each pair of Billings sampling stations, while Table 23 is a summary of the T-test results. The geographic location of the Billings TSP monitors are provided on Figure 30.

5. TSP levels at the Lockwood School site show a poor correlation (R=0.5223) with the Grand Avenue School site, a fair correlation (R=0.6408) with the City Hall site, a good correlation (R=0.7146) with the Taft School site, and a very good correlation (R=0.8193) with the KGHL site.

TABLE 22

CORRELATION COEFFICIENTS OF TOTAL SUSPENDED PARTICULATE DATA FROM BILLINGS MONITORING SITES

	Lockwood School	KGHL Radio	City Hall	Grand Ave. School	Taft School
Lockwood School	--	0.8193 (53) P=0.000	0.6408 (50) P=0.000	0.5223 (51) P=0.000	0.7146 (51) P=0.000
KGHL Radio Station	0.8193 (53) P=0.000	---	0.6900 (53) P=0.000	0.5592 (54) P=0.000	0.8021 (53) P=0.000
City Hall	0.6408 (50) P=0.000	0.6900 (53) P=0.000	---	0.8928 (51) P=0.000	0.8473 (51) P=0.000
Grand Avenue School	0.5223 (51) P=0.000	0.5592 (54) P=0.000	0.8928 (51) P=0.000	---	0.7889 (51) P=0.000
Taft School	0.7146 (51) P=0.000	0.8021 (53) P=0.000	0.8478 (51) P=0.000	0.7889 (51) P=0.000	---

Note: 0.8193 = correlation coefficient
(53) = number of data pairs
P=0.000 = one tailed probability

TABLE 23

T-TEST RESULTS OF THE COMPARISON
OF TOTAL SUSPENDED PARTICULATE DATA FROM
BILLINGS MONITORING SITES

	KGHL Radio Station	City Hall	Grand Avenue School	Taft School
Lockwood School	0.2453 11.173 0.16 P=0.874	-20.6000 19.213 - 7.58 P=0.000	-16.6471 20.513 - 5.80 P=0.000	-19.8824 25.659 - 5.53 P=0.000
KGHL Radio Station	---	-24.2075 19.932 - 8.84 P=0.000	-18.9444 19.720 - 7.06 P=0.000	-21.4340 23.666 - 6.59 P=0.000
City Hall	---	---	3.7843 12.724 2.12 P=0.039	0.6078 19.520 0.22 P=0.825
Grand Avenue School	---	---	---	- 3.1569 23.451 - 0.96 P=0.341

Note: 0.2453 = mean of the differences
11.173 = standard deviation of the differences
0.16 = t value
P=0.874 = two tailed probability

Since the climate is similar throughout this section of the Yellowstone Valley, the AQB concludes that the Lockwood School site is being influenced by a different set of emission sources than either the Grand Avenue School site or City Hall. This conclusion is reinforced by the fact that Lockwood School is located in a mixed industrial-residential setting while the Grand Avenue School and City Hall sites are in areas of dense commercial development. A factor analysis described in the 1981 Network Review was also consistent with this conclusion, since it

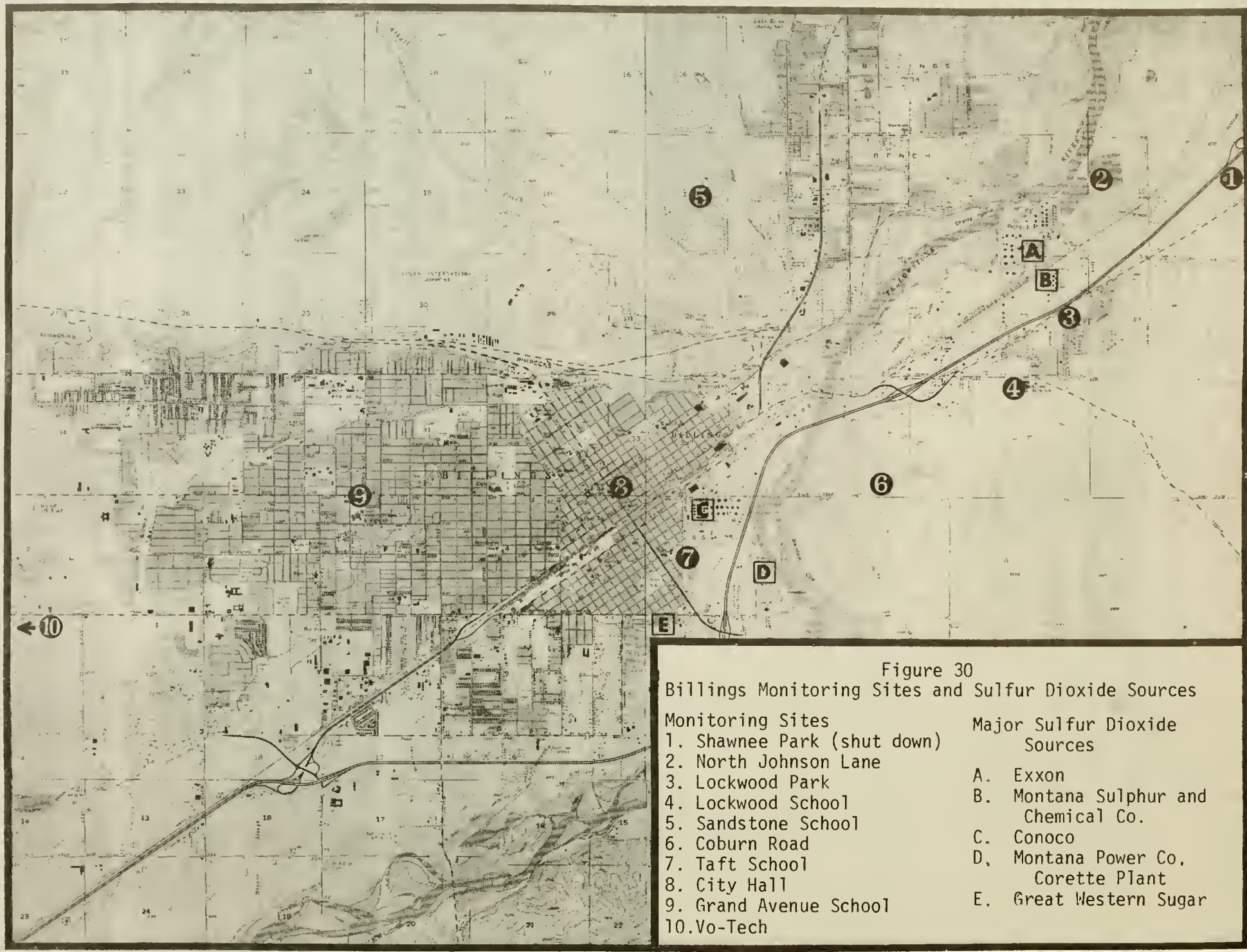


Figure 30
Billings Monitoring Sites and Sulfur Dioxide Sources

Monitoring Sites
1. Shawnee Park (shut down)
2. North Johnson Lane
3. Lockwood Park
4. Lockwood School
5. Sandstone School
6. Coburn Road
7. Taft School
8. City Hall
9. Grand Avenue School
10. Vo-Tech

Major Sulfur Dioxide Sources

A. Exxon
B. Montana Sulphur and Chemical Co.
C. Conoco
D. Montana Power Co. Corette Plant
E. Great Western Sugar

suggested that the Lockwood School site was being influenced by industrial fugitive emissions while the Grand Avenue and City Hall sites were generally sampling road dust.

Since the Lockwood School TSP data correlated well with Taft School and especially the KGHL Radio Station, it is likely that all three sites are sampling similar emission sources. Although the Taft School site is located in an industrial-residential setting similar to Lockwood School, the KGHL site is not. The KGHL Radio Station is in an agricultural-residential area. Surprisingly, the data from the Lockwood School site and the KGHL site not only correlated well, but the t-test (P=0.874) indicates that the hypothesis that the two means are equal cannot be rejected. The actual means for the two sites were very close at 38 ug/m^3 for the KGHL site and 37 ug/m^3 for the Lockwood Park monitor. The factor analysis described in the 1981 Network Review indicated that the KGHL site was being influenced by industrial fugitive emissions just like the Lockwood School monitor.

All the evidence indicates that the Lockwood School and the KGHL sites are being influenced by identical or very similar emission sources. Since they are geographically separated by approximately 10 miles and a bottleneck in the Yellowstone Valley, they are most likely monitoring a very similar mixture of emission sources.

In light of the low concentrations observed at the Lockwood School site and in order to save money and manpower, the AQB recommends moving this high volume sampler approximately .7 miles northeast to the Lockwood Park sulfur dioxide site.

6. The KGHL site was located in an agricultural-residential area southwest of Billings. During 1982 a geometric mean of 38 ug/m^3 was recorded. The KGHL site appears to serve as an upwind or background site for the city of Billings.

   The total suspended particulate data from the KGHL site displayed very good correlations (R=0.8193 and R=0.8021) with the Lockwood Park and Taft School sites; a fair correlation (R=0.6900) with the City Hall site; and a poor correlation (R=0.5592) with the Grand Avenue School site. These correlation coefficients and all other evidence indicates that the discussion about the Lockwood School site contained in paragraph 3 is also appropriate for KGHL.

   In December of 1982 the Yellowstone County Air Pollution Control Agency moved the KGHL site to the Sandstone School in the Bench area of Billings. The move was consistent with the 1982 Network Review which recommended a monitor in this rapidly expanding area of Billings.

7. The Grand Avenue School site is located along a major commercial arterial. TSP levels at the Grand Avenue School site displayed a poor correlation (R=0.5223 and R=0.5592) with similar data from the Lockwood School and KGHL sites. The correlation with data from the Taft School site was good (R=0.7889) while a very good correlation (R=0.8928) was observed with City Hall concentrations.

   These correlations are consistent with the result of a similar analysis conducted in conjunction with the 1981 Network Review. The 1981 Network Review also described a factor analysis which indicated that both the City Hall and Grand Avenue sites were significantly influenced by road dust. The conclusion that both sites are being influenced by road dust is reinforced by the fact that the geometric means differ by only 3 ug/m3.

The AQB recommends that the Grand Avenue School high volume sampler continue to be operated because of its historical significance and its strategic location for tracking TSP levels in a major commercial area.

8. The City Hall site is situated in the downtown area of Billings and was the site responsible for the non-attainment designation of the central business district. Emission inventories and associated modeling performed in 1977 by PEDCo-ENVIRONMENTAL INC. as part of the Billings SIP revision showed that road dust from paved roads was the major contributor to TSP at the City Hall site. A factor analysis described in the 1981 Network Review also identified road dust as the major source of TSP influencing the site.

   The TSP data from the City Hall site showed fair correlations (R=0.6408 and R=0.6900) with levels from Lockwood School and KGHL and very good correlations (R=0.8928 and R=0.8478) with Grand Avenue and Taft School.

   Due to the high geometric mean and the need to track the effectiveness of the non-attainment area control strategies, the AQB believes this site is essential.

9. The Taft School site is located in an older residential area and near a major industrial district comprised of the Conoco Refinery, Great Western Sugar Company and the Montana Power Company Corette Plant.

   TSP concentrations exhibited very good correlations (R=0.8478 and R=0.8021) with data from the City Hall and KGHL sites and fair correlations (R=0.7889 and R=0.7146) with concentrations at the Grand Avenue School and Lockwood School sites. The geometric mean for the Taft School site was only 5 ug/m^3 less than that for the City Hall site and the t-test indicated a high probability that both means are identical.

The AQB recommends continued operation of this NAMS site.

10. Generally Billings TSP levels are the result of fugitive dust from vehicle traffic on paved roads and to a lesser degree automotive exhaust or industrial emissions. The TSP network has a good geographical distribution especially with the addition of the Sandstone School and the Lockwood Park sites.

Eastern Montana

In 1980 the AQB initiated total suspended particulate sampling in several eastern Montana cities. These cities included: Lewistown, Havre, Miles City and Glendive. A site at Sidney was added in January of 1983. The sites were to fill a geographical data void and to establish a TSP baseline for eastern Montana's larger communities. Now that two full years of data have been collected, the AQB recommends major changes to the eastern Montana network. The following pages outline these changes.

Figures 32 and 33 show the monitoring site locations in Glendive and Sidney, while Figure 35 shows the general locations of the other sites. Table 24 provides a summary of the TSP data for each of the eastern Montana sites.

Havre

1. The Havre high volume sampler is located on a rooftop near the center of town. Over the last three years the geometric mean at this site has remained relatively low.
2. Since a good data base was established and because the TSP concentrations were low, the AQB discontinued the site in July of 1983.

Malta and Plevna

1. The Bureau of Land Management has contracted the AQB to operate background sites at a location near Plevna in southeastern Montana and on the Bowdoin National Wildlife Refuge near Malta, Montana. Both sites were part of the original BLM network established in 1981. The Plevna site was started up again by the AQB in January of 1983, while the Bowdoin site commenced operation in August of 1983.

Lewistown

1. The Lewistown monitor was located on the roof of the Midstate Bank Building one block off the main street. During 1980 and 1981 the AQB had problems retaining an operator and did not collect sufficient data to constitute valid annual averages. In 1982 sufficient data was collected and the geometric mean was low at 40 ug/m^3. The AQB shut down the site in July of 1983.

Jordan

1. In June of 1982 the Bureau of Land Management terminated TSP sampling at a location near Jordan, Montana. Since the site met the requirements established for a background site, the AQB decided to take over the site. The only drawback to this location is a small seam of lignite coal which lies under the area. However, the seam is only four feet thick and unlikely to be of any commercial value. The AQB plans to operate the monitor as a long-term background station.
2. In 1982 the geometric mean for the Jordan site was 10 ug/m^3. The highest 24-hour reading was also extremely low at 28 ug/m^3. Figure 31 shows the location of the Jordan sampler.

Miles City

1. The Miles City site was located on top of the PCA Building and registered a geometric mean for TSP in 1982 of 40 ug/m^3. The AQB shut down this site in July of 1983 due to consistently low concentrations.

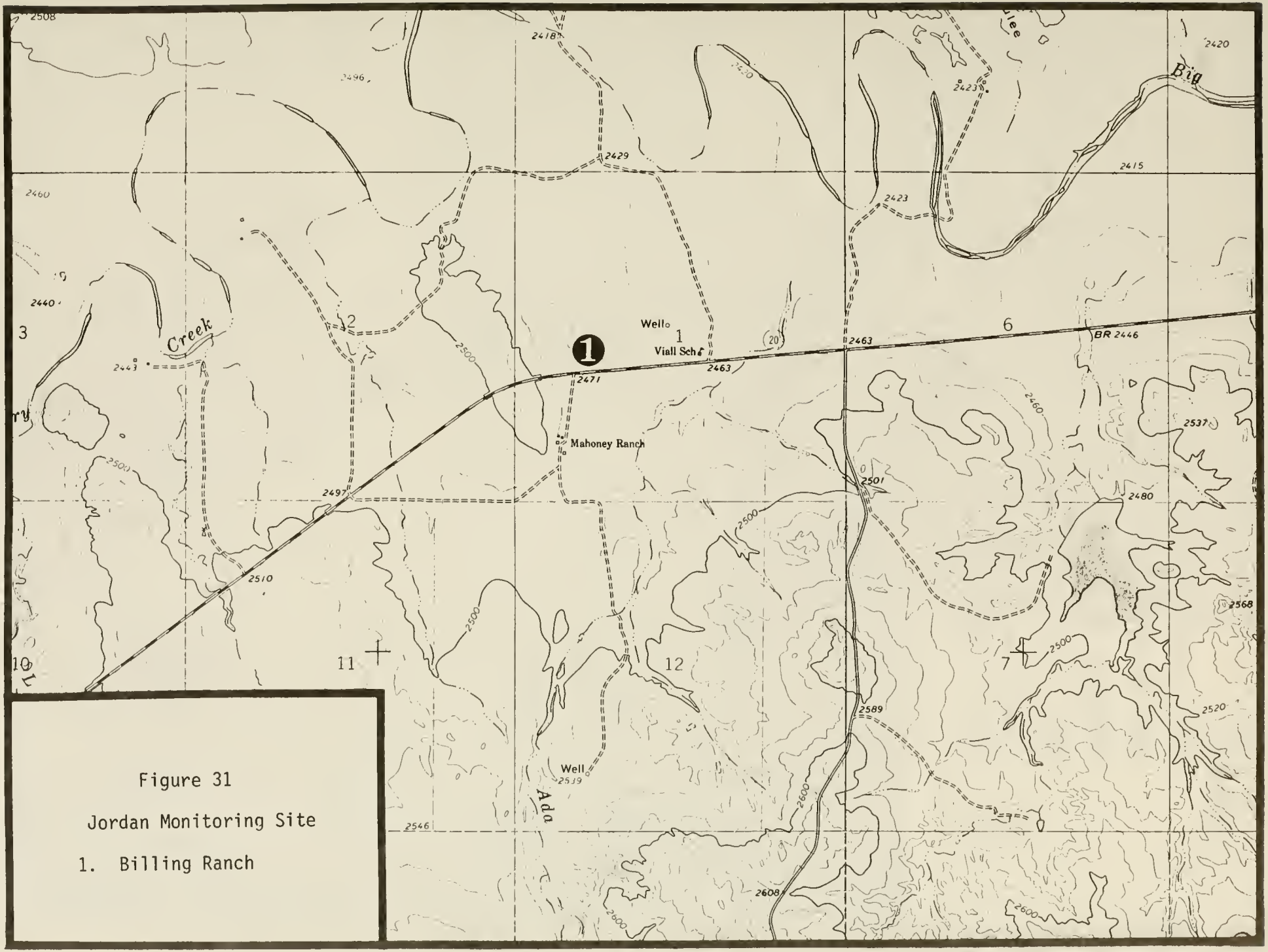


Figure 31

Jordan Monitoring Site

1. Billing Ranch

Glendive

1. Until September of 1982 the Glendive monitoring site was located at Dawson Community College. Since the college is upwind and above the city of Glendive, the AQB believed that the site was operating as a background site. Therefore, in September of 1982 the monitor was moved to the roof of the Medical Arts Building within the city of Glendive.
2. The TSP concentrations at the new site for the last four months of 1982 had a geometric mean of 25 ug/m^3. This level was only slightly higher than the average for the other eight months of 1982 at the old site.
3. The AQB intends to operate the monitor at the Medical Art Building at least until July of 1984.

Sidney

1. Sidney is a city of approximately 5700 people and is experiencing a boom as a result of the oil and gas industry. In order to track this development, the AQB installed a high volume sampler in downtown Sidney during January of 1983. The AQB intends to run this site for at least one calendar year.

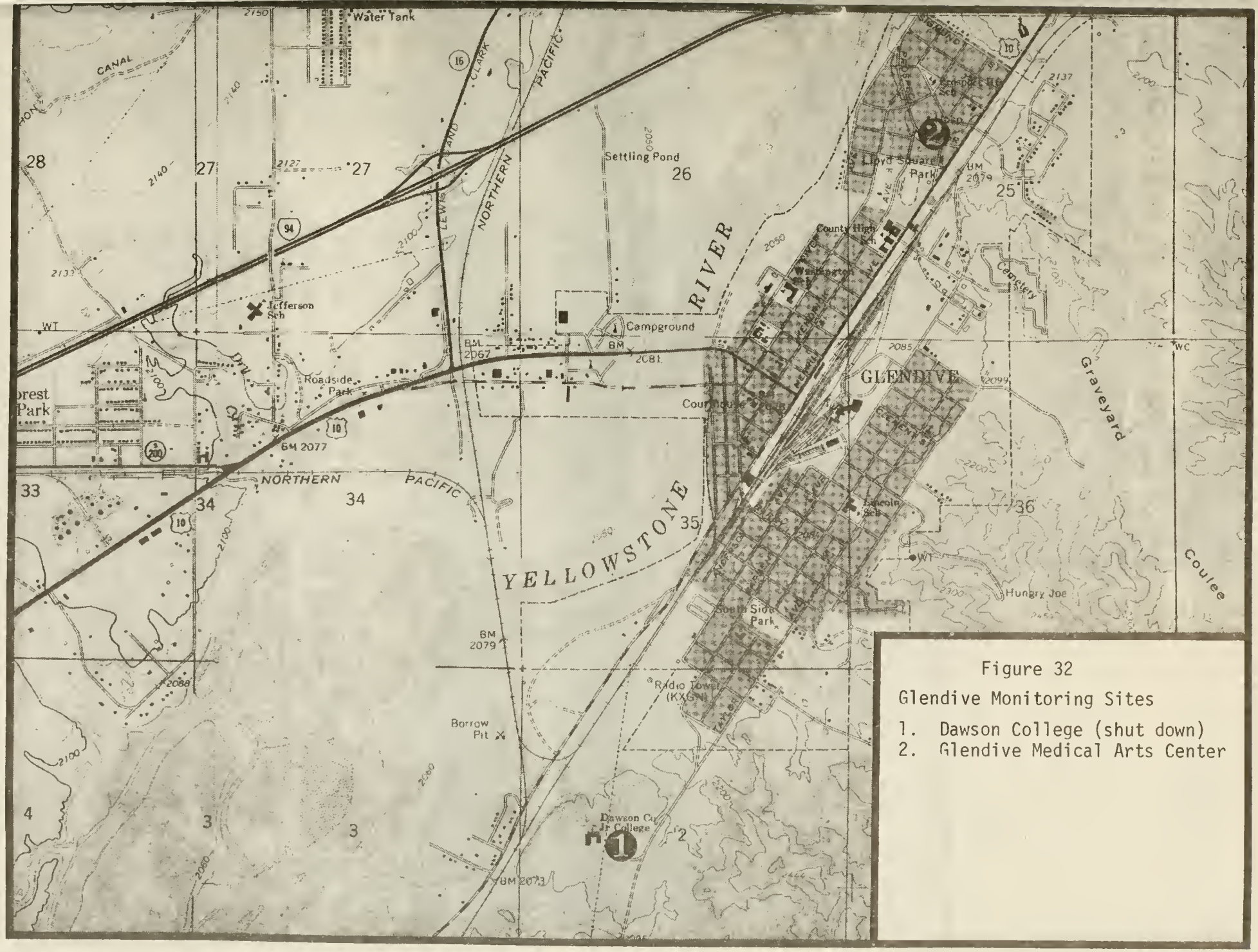


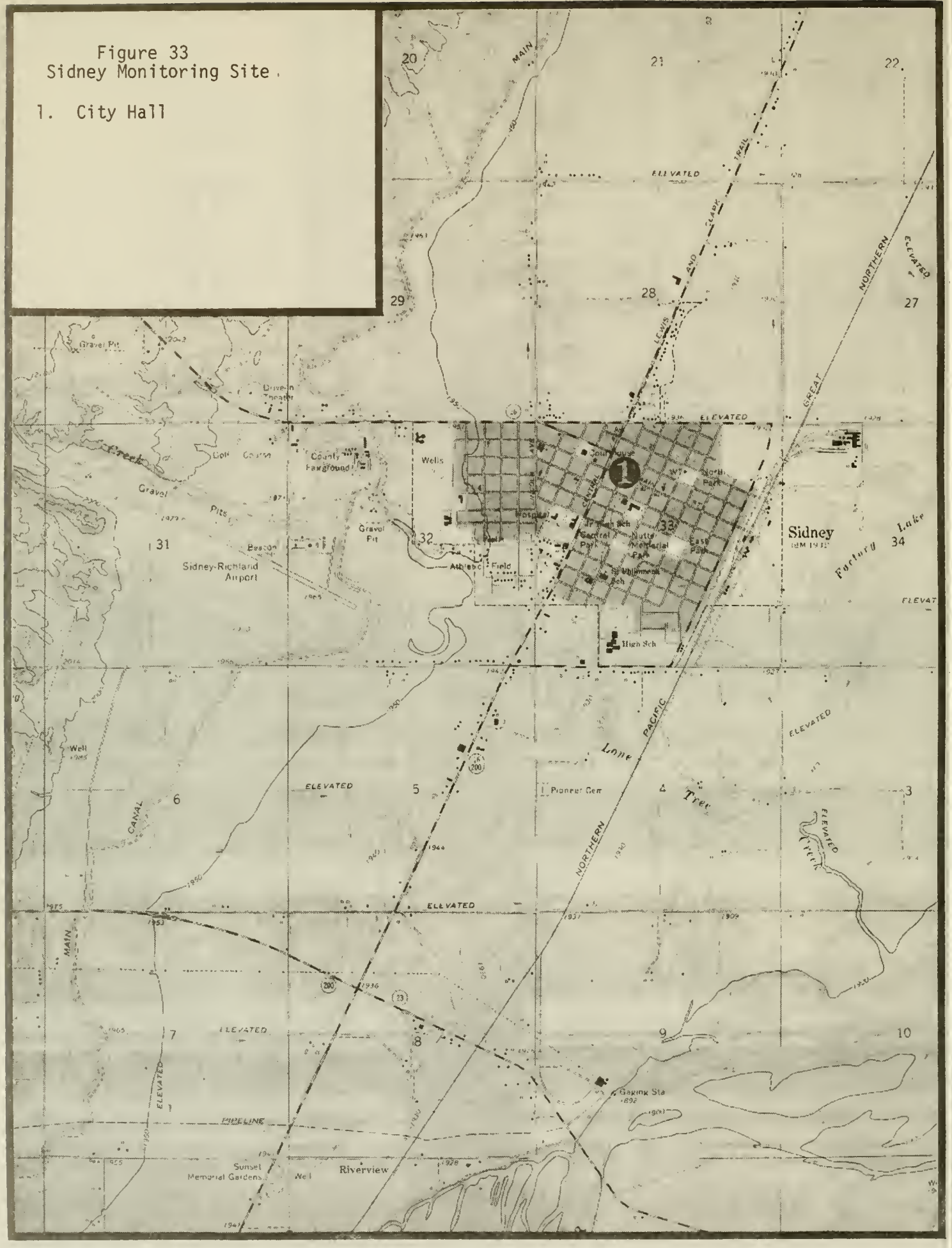
Figure 32

Glendive Monitoring Sites

1. Dawson College (shut down)
2. Glendive Medical Arts Center

Figure 33
Sidney Monitoring Site

1. City Hall



Poplar River

Scobey

1. Scobey is a small community of 1500 people located in northeastern Montana. It lies fourteen miles south of the Canadian Border and 22 miles south of the new Saskatchewan Power Company electrical generating facility. The power plant consists of two 300 megawatt coal-fired generating units. The first unit went on line commercially in November of 1980 and the second went on line in July of 1983.
2. The AQB operates three TSP monitors in the Scobey area: one at the Canadian Border (Border), one 13 miles northeast of Scobey (Hanrahan) and the other just north of town (Richardson). Particulate concentrations at all three locations are very low and essentially represent background conditions. The startup of the first unit has had no noticeable impact on the TSP levels.
3. The Montana Legislature has funded the Scobey air monitoring project for one additional year with the starting date contingent on when both units of the Saskatchewan plants reach continuous operation. The AQB expects this condition to be met sometime between October 1983 and July of 1984. Therefore, the sites were temporarily shut down on July 1, 1983 until the new starting date is established.
4. Figure 34 shows the locations of the Poplar River monitoring sites while Table 24 summarizes the TSP data.

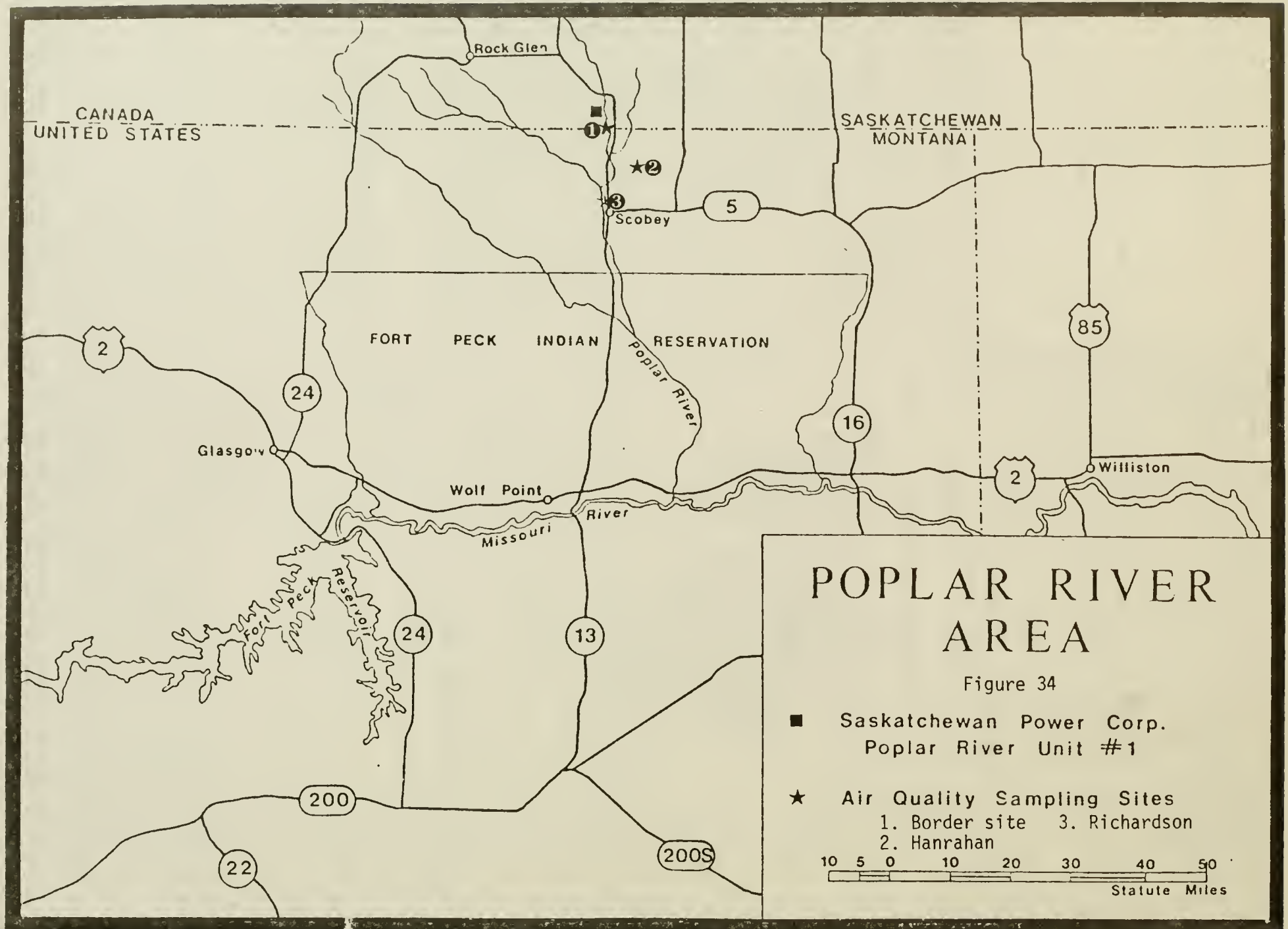

Rock Glen
CANADA
UNITED STATES
SASKATCHEWAN
MONTANA
Scobey
5
FORT PECK INDIAN RESERVATION
Poplar River
85
2
24
16
Glasgow
Wolf Point
Missouri River
Williston
Fort Peck Reservoir
13
200
200S
22
POPLAR RIVER AREA
Figure 34
Saskatchewan Power Corp.
Poplar River Unit #1
Air Quality Sampling Sites
1. Border site
2. Hanrahan
3. Richardson
10 5 0 10 20 30 40 50
Statute Miles

TABLE 24

SUMMARY OF TSP CONCENTRATIONS AT MONTANA SAMPLING LOCATIONS

SITE	1981 Geo. Mean	1981 1-High	1981 2-High	1982 Geo. Mean	1982 1-High	1982 2-High
Libby-Brown Residence	120	444	378	92	346	282
Whitefish-Park	*67	144	128	49	138	130
Kalispell-U.A.	81	211	186	73	234	232
Kalispell-Evergreen	53	170	159	44	176	176
Polebridge	25	89	62	14	89	60
Flathead-Airport	32	134	103	24	94	89
Columbia Falls-NAAC	25	89	83	14	49	45
Columbia Falls-Anders Res.	108	494	390	66	241	225
Glacier Nat. Park-West	13	69	59	12	51	46
Glacier Nat. Park-East	* 6	23	20	* 5	44	18
Bigfork-Ranger Station	28	109	84	25	80	78
Polson	36	174	111	36	100	95
Swan River	--	--	--	23	306	236
Ronan-Ninepipe	18	142	55	13	71	54
Missoula-HW#1	25	106	96	26	102	86
Missoula-HW#2	25	122	100	26	109	105
Missoula-Courthouse	62	220	216	55	256	216
Missoula-Schilling St.	*102	358	272	--	--	--
Missoula-McLeod Park	*100	146	111	--	--	--
Missoula-Rose Park	56	208	187	52	381	312
Missoula-Northside	--	--	--	*58	138	127
Missoula-Boyd Park	*81	195	160	72	319	309
Missoula-Lolo	--	--	--	*47	90	85
Ovando-Terry Smith	16	98	71	14	79	79
Anaconda-Lincoln School	45	149	142	35	128	125
Anaconda-Hiway Jct.	*19	59	57	--	--	--
Warm Springs	26	161	135	--	--	--
Ramsay-Tierney Res.	35	113	89	--	--	--
Walkerville-Blaine Sch.	30	85	79	21	66	51
Butte-Dr. Canty	49	245	228	37	158	137
Butte-Hebgen Park	65	263	177	47	184	153
Butte-Greeley Sch.	78	346	247	57	225	216
Monida-BLM	* 7	28	18	* 7	30	28
Helena-Capital Courts	52	248	220	51	183	166
Helena-Sunhaven	*48	108	86	--	--	--
Helena-Cooney Home	--	--	--	*31	75	70
Helena-Valley Bank	42	250	128	--	--	--
Helena-Cogswell Bldg.	40	191	121	42	114	113
Helena-Super Save	--	--	--	58	188	166
E. Helena-Padbury	*33	126	108	--	--	--
E. Helena-Dartman	*44	112	107	*37	85	83
E. Helena-Hadfield	*80	242	203	*61	133	121
E. Helena-Firehall	*81	234	218	--	--	--
E. Helena-Hasties	67	230	209	*56	102	101
E. Helena-A&W	55	267	190	--	--	--
E. Helena-Canal	46	406	187	--	--	--
E. Helena-Vollmer	36	180	177	--	--	--
E. Helena-South	*39	115	102	*38	88	80
E. Helena-Microwave	25	63	54	--	--	--

*Less than eight months of data

SITE	1981 Geo. Mean	1981 1-High	1981 2-High	1982 Geo. Mean	1982 1-High	1982 2-High
Montana City-School	*73	422	240	*73	188	182
Great Falls-Riverview Sch.	45	141	124	40	120	109
Great Falls-Downtown	55	200	127	49	107	107
Great Falls-Fire Sta.	69	291	192	67	204	180
Great Falls-Lincoln Sch.	48	164	128	44	124	99
Great Falls-Kiwanis Park	43	131	117	39	89	75
Great Falls-Black Eagle	58	166	142	64	216	144
Great Falls-CCHD	*43	157	87	--	--	--
Bozeman-Traphagen	25	69	60	25	59	56
Bozeman-MSU Housing	57	398	350	--	--	--
Bozeman-Whittier Sch.	*56	89	74	47	143	125
Bozeman-East Main	68	246	194	56	265	180
Havre-Central Bldg.	59	162	145	58	183	160
Lewistown-Downtown	*62	130	116	40	125	96
Laurel-Jr. High	39	126	83	33	77	74
Laurel-New Farm	43	142	134	*28	107	60
Billings-KGHL	47	171	160	38	92	89
Billings-Grand Ave.	72	165	157	56	124	119
Billings-City Hall	69	182	155	59	153	107
Billings-Taft Sch.	64	271	234	54	162	152
Billings-Lockwood	47	148	102	37	100	82
Malta/BLM	*14	27	20	*16	65	41
Scobey-Border	28	1358	637	17	234	50
Scobey-Richardson	*34	452	82	*13	63	28
Scobey-Hanrahan	23	544	294	16	144	47
Jordan	* 9	17	14	10	28	28
Miles City-PCA	52	145	129	40	118	106
Glendive-Dawson College	23	180	55	22	54	48
Glendive-Medical Arts. Bldg.	--	--	--	*25	66	52
Lindsay-Weilgosh	32	206	176	*23	74	24
Plevna/BLM	*24	60	34	*22	98	79
Decker-Thomas Ranch	*29	64	59	--	--	--
Decker-Coal #2	*41	95	74	--	--	--
Decker-Coal #6	--	--	--	26	192	138

*Less than eight months of data

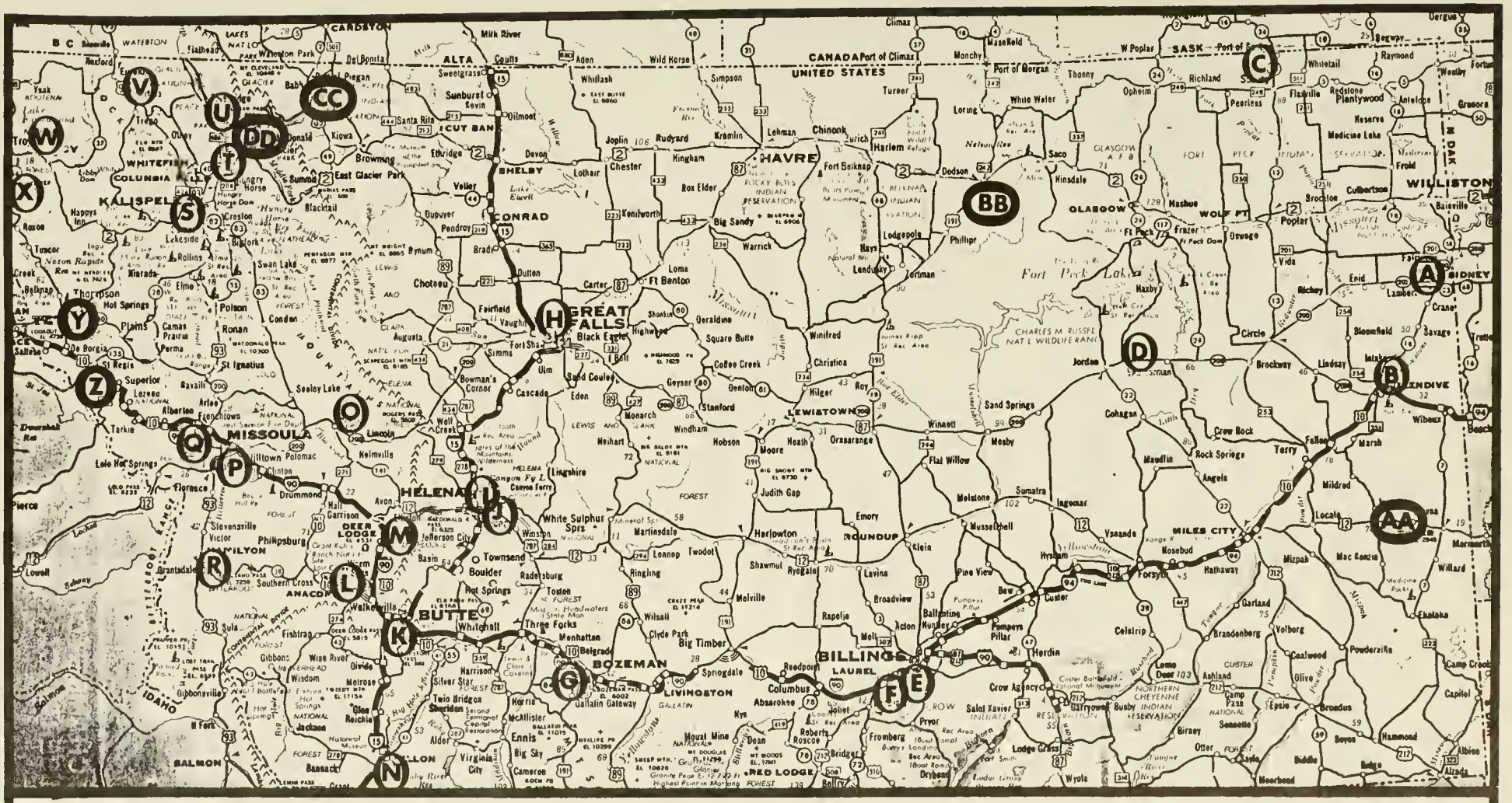


Figure 35

A. Sidney, figue 33
B. Glendive, figure 32
C. Scobey, figure 34
D. Jordan, figure 31
E. Billings, figure 30
F. Laurel, figure 29
G. Bozeman, figure 23
H. Great Falls, figure 28
I. Helena, figure 17
J. East Helena, figure 18
K. Butte, figure 22
L. Anaconda, figure 19
M. Deer Lodge, figure 15
N. Dillon, figure 25
O. Ovando
P. Missoula, figure 11
Q. Hoerner Waldorf 1&2
R. Hamilton, figure 14
S. Kalispell, figure 9
T. Columbia Falls, figure 6
U. Polebridge, figure 5
V. Eureka
W. Libby, figure 3
X. ASARCO Troy
Y. Thompson Falls, figure 4
Z. Superior
AA. Plevna
BB. Malta
CC. St Marys
DD. West Glacier

LEAD-Pb

On October 5, 1978, the EPA promulgated an ambient air quality standard for lead (1.5 ug/m^3 quarterly arithmetic mean). As a criteria pollutant, the EPA required monitoring for lead in urbanized areas over 500,000 population, in the vicinity of certain categories of major stationary sources which are known lead emitters, and in areas known to be exceeding the standard. In Montana, two areas were affected by these regulations: the area surrounding the Anaconda Copper Smelter in Anaconda, and in the vicinity of the ASARCO lead smelter in East Helena.

Anaconda

1. During July of 1980, a labor strike closed the Anaconda smelter. In September, management announced the permanent closure of the plant. The AQB will continue to conduct lead monitoring in the Anaconda area at the Lincoln School site as long as lead analysis is being done on a routine basis in East Helena. This will provide information on the decay of ambient lead concentrations.

East Helena

1. The AQB and the ASARCO lead smelter are presently operating a lead sampling network in the East Helena area as part of the Montana SIP requirements. Table 25 describes the network, while Figure 18 shows the geographical locations of the sites. The present network is a condensed version of the more elaborate network operated during 1981.
2. The 1981 network was described in the 1982 Network Review and was designed to determine the geographical extent of high ambient lead concentrations. The AQB with the assistance of ASARCO is continuing to operate all lead monitors which exhibited violations of the federal lead standard. These sites include the South, Hastie, Hadfield, Dartman, and

TABLE 25

EAST HELENA LEAD MONITORING NETWORK

Site	Location	Parameters	Equipment	Responsible Organization (Field/Laboratory)
Hastie residence	212 Pacific .2 miles north of smelter slag pile	TSP	Hi-vol	ASARCO/AQB
		Pb	Hi-vol	ASARCO/AQB
		elemental	Lo-vol	ASARCO/ASARCO
Hadfield	Hadfield TV Repair Main Street, .2 miles north of smelter	TSP	Hi-vol	ASARCO/AQB
		Pb	Hi-vol	ASARCO/AQB
		elemental	Lo-vol	ASARCO/ASARCO
Firehall	East Helena Firehall Pacific Street .2 miles north of smelter	TSP	Hi-vol	ASARCO/AQB
		Pb	Hi-vol	ASARCO/AQB
		elemental	Lo-vol	ASARCO/ASARCO
South	Kleffner Field .5 miles SSE of smelter	TSP	Hi-vol	AQB/AQB
		Pb	Hi-vol	AQB/AQB
Dartman	North edge of East Helena, .5 miles north of smelter	TSP	Hi-vol	AQB/AQB
		PB	Hi-vol	AQB/AQB

Firehall sites. The AQB will also perform lead analyses on filters from the Montana City site, since it is in the vicinity of East Helena, and even though its primary objective is to monitor TSP. The Hadfield, Hastie, and Firehall sites are operated on a one-in-three day cycle by ASARCO, while the South, Dartman, and Montana City samplers are operated by the Bureau on the standard six-day cycle.

3. The ASARCO sites will also be equipped with low volume samplers utilizing teflon filters. These filters will be sent to a private laboratory for chemical analysis by x-ray fluorescence and the data will be used to perform a chemical mass balance (CMB). The results of the CMB analysis will allow both parties to track the lead control strategies on a source specific basis.

4. Table 26 summarizes the lead data for the East Helena area for 1982. There is no data for the first half of 1982, since the samplers were maintained in a ready condition to monitor unusual conditions such as wind storms and severe inversions. During the third quarter of 1982 only the South site had sufficient data to calculate a valid quarterly average. The average lead concentration for the quarter was 1.52 ug/m^3, or just slightly over the standard. In the fourth quarter, both the Hastie and the Hadfield sites registered quarterly means above the standard. The Hadfield mean of 2.23 ug/m^3 was the highest quarterly average in 1982.

TABLE 26

EAST HELENA LEAD DATA FOR 1982
(ug/m^3)

	3rd quarter		4th quarter	
Site	Average	Max. 24-hour	Average	Max. 24-hour
Hastie	*2.19(9)	5.20	2.23(15)	4.08
South	1.52(13)	4.28	.90(12)	2.26
Hadfield	*2.64(7)	4.29	1.95(15)	6.18
Dartman	*1.99(9)	3.73	1.23(15)	2.91
Montana City	* .12(10)	0.33	--	--

Note: ( ) denote the number of sampling days
* Insufficient data to constitute a valid quarterly average

5. Tables 27, 28 and 29 give the results of the statistical analyses performed on the East Helena lead data. During 1981, a detailed chemical mass balance analysis was performed by NEA of Beaverton, Oregon to determine the source contributions at most of the sampling locations. Figures 36, 37 and 38 display a portion of the CMB results.

6. The Hastie residence sampler has monitored ambient lead concentrations since 1977. It is located at 212 Pacific Street, directly across Highway 12 from the ASARCO smelter slag pile. The site has exceeded the 1.5 ug/m^3 quarterly standard over its entire history. In 1982 it

registered the highest quarterly lead concentration in the state at 2.23 ug/m^3.

The lead data from the Hastie residence sampler correlated very poorly with all other East Helena lead sites. Apparently the Hastie residence monitor is being influenced by a different set of emission sources than the other sites. A review of the CMB results for the fourth quarter of 1981 at the Hadfield and Hastie residence site reinforces this conclusion. Although the CMB analysis determined that both sites receive approximately one-third of the measured lead from the ASARCO blast furnace, other major contributing sources showed large differences. For example, at the Hadfield site road and soil dust contributed 54 percent of the lead, while at Hastie it only accounted for 20 percent of the lead. Likewise, zinc oxide material accounted for 41 percent of the lead at Hastie but less than six percent at the Hadfield site. The results of the t-test indicate that the hypothesis that the mean lead concentration for the Hastie residence is equal to those of the Hadfield and Dartman sites cannot be rejected. However, in light of the poor correlation between the sites, these results should be discounted.

TABLE 27

CORRELATION COEFFICIENTS OF LEAD DATA FROM
EAST HELENA MONITORING SITES

	Hastie	South	Hadfield	Dartman
Hastie	--	-0.2801 (21) P=0.109	0.2120 (20) P=0.185	0.2551 (23) P=0.120
South	-0.2801 (21) P=0.109	--	0.0482 (21) P=0.418	-0.1153 (26) P=0.288
Hadfield	0.2120 (20) P=0.185	0.0482 (21) P=0.418	--	0.9299 (25) P=0.000

Note: -0.2801 = correlation coefficient
(21) = number of data pairs
P=0.109 = one tailed probability

TABLE 28

T-TEST RESULTS OF THE COMPARISON OF LEAD
DATA FROM EAST HELENA MONITORING SITES

	Hastie	South	Hadfield	Dartman
Hastie	--	- 0.8810 1.856 - 2.18 P=0.042	-0.1990 1.932 -0.46 P=0.650	-0.1970 1.876 -0.50 P=0.620
South		--	-1.3452 1.957 -3.15 P=0.005	-1.4746 2.049 -3.67 P=.001
Hadfield			--	-0.2984 0.646 -2.31 P=0.030

Note: -42.0867 = mean of the differences
21.686 = standard deviation of the differences
- 8.89 = t-value
P=0.000 = two tailed probability

Results of a regression analysis comparing lead and total suspended particulate data (see Table 29) at the Hastie residence site indicated that the source of lead is different from the source of TSP. The CMB results showed that the blast furnace is a major source of lead but only a minor source of TSP (see Figure 36).

TABLE 29

CORRELATION COEFFICIENTS OF LEAD AND TOTAL SUSPENDED PARTICULATE DATA FROM EAST HELENA MONITORING SITES

Site	Correlation Coefficient	Data Pairs	One tailed Probability
Hastie, Lead vs. TSP	R=0.3786	25	P=0.031
South, Lead vs. TSP	R=0.2980	28	P=0.062
Hadfield, Lead vs. TSP	R=0.7956	25	P=0.000
Dartman, Lead vs. TSP	R=0.7756	30	P=0.000

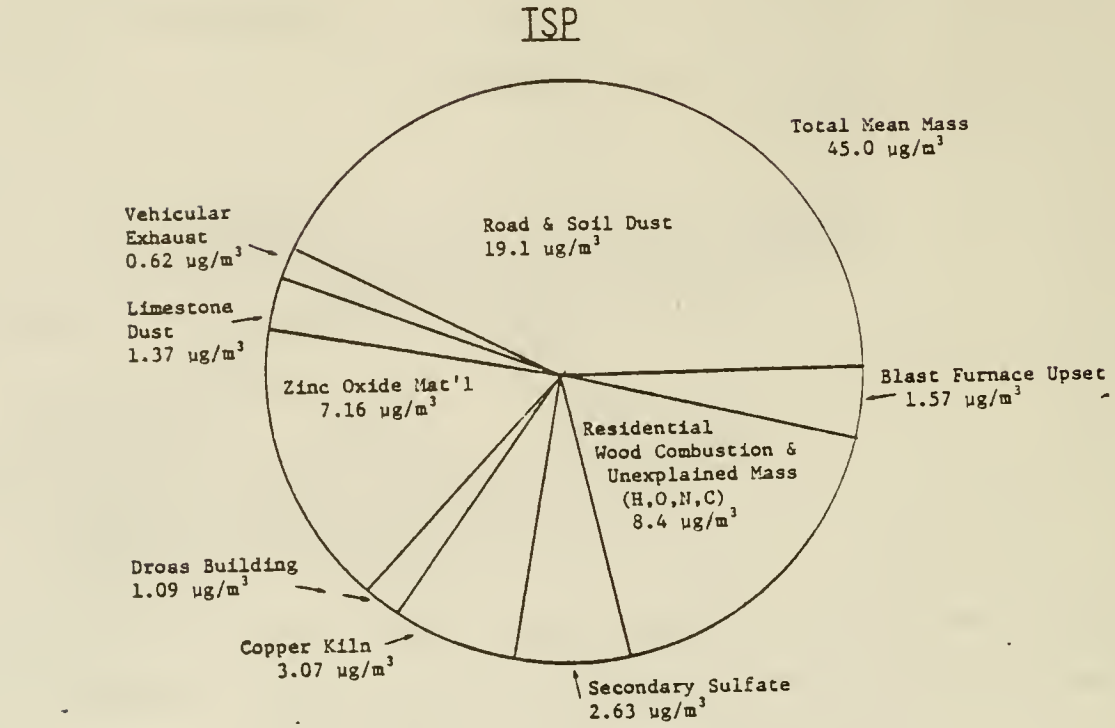
The AQB and ASARCO intend to monitor lead at the Hastie residence at least for another three years. The site provides a good historical record and is essential for SIP tracking.

7. The Hadfield monitor is located .2 miles north of the ASARCO smelter and American Chemet. It is situated south of Main Street and about five blocks west of the Hastie site. In 1982 it recorded one valid quarterly average above the standard at 1.95 ug/m^3. Higher readings were observed in 1981.

   Lead data from the Hadfield site showed a poor correlation with the Hastie residence (R=0.2120) and the South site (R=0.0482) but an excellent correlation with the Dartman site. Apparently the Hadfield site is being influenced by different emission sources than the Hastie residence or South sites. The good correlation with the Dartman site is

Figure 36

CMB Source Apportionment- Hastie Site, 4th Quarter



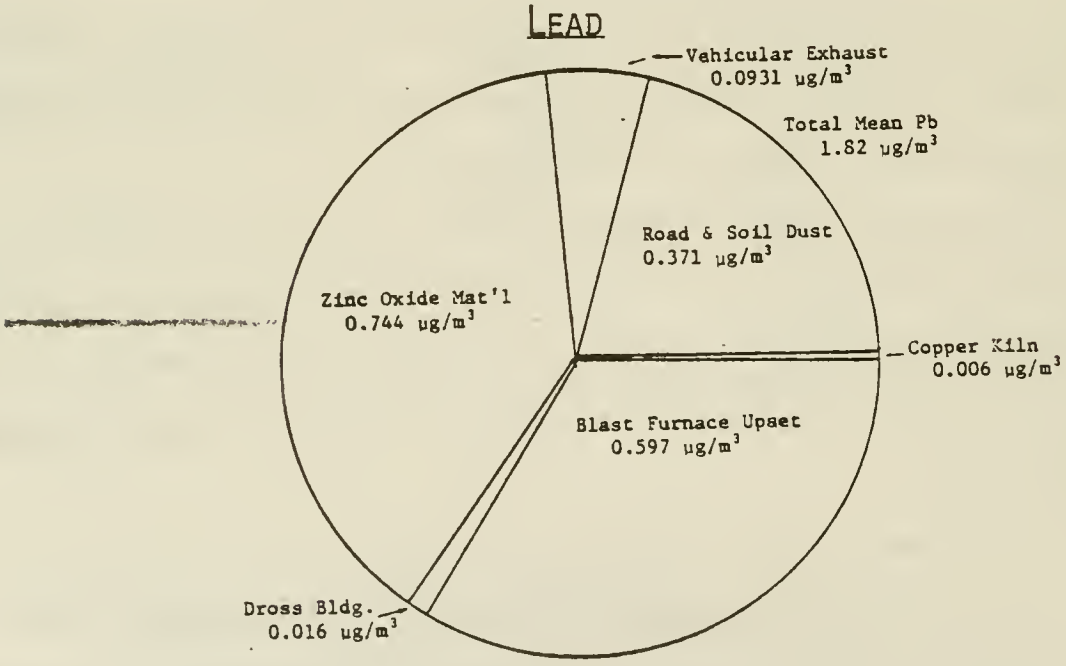


Figure 37

CMB Source Apportionment- Hadfield Site, 3rd Quarter

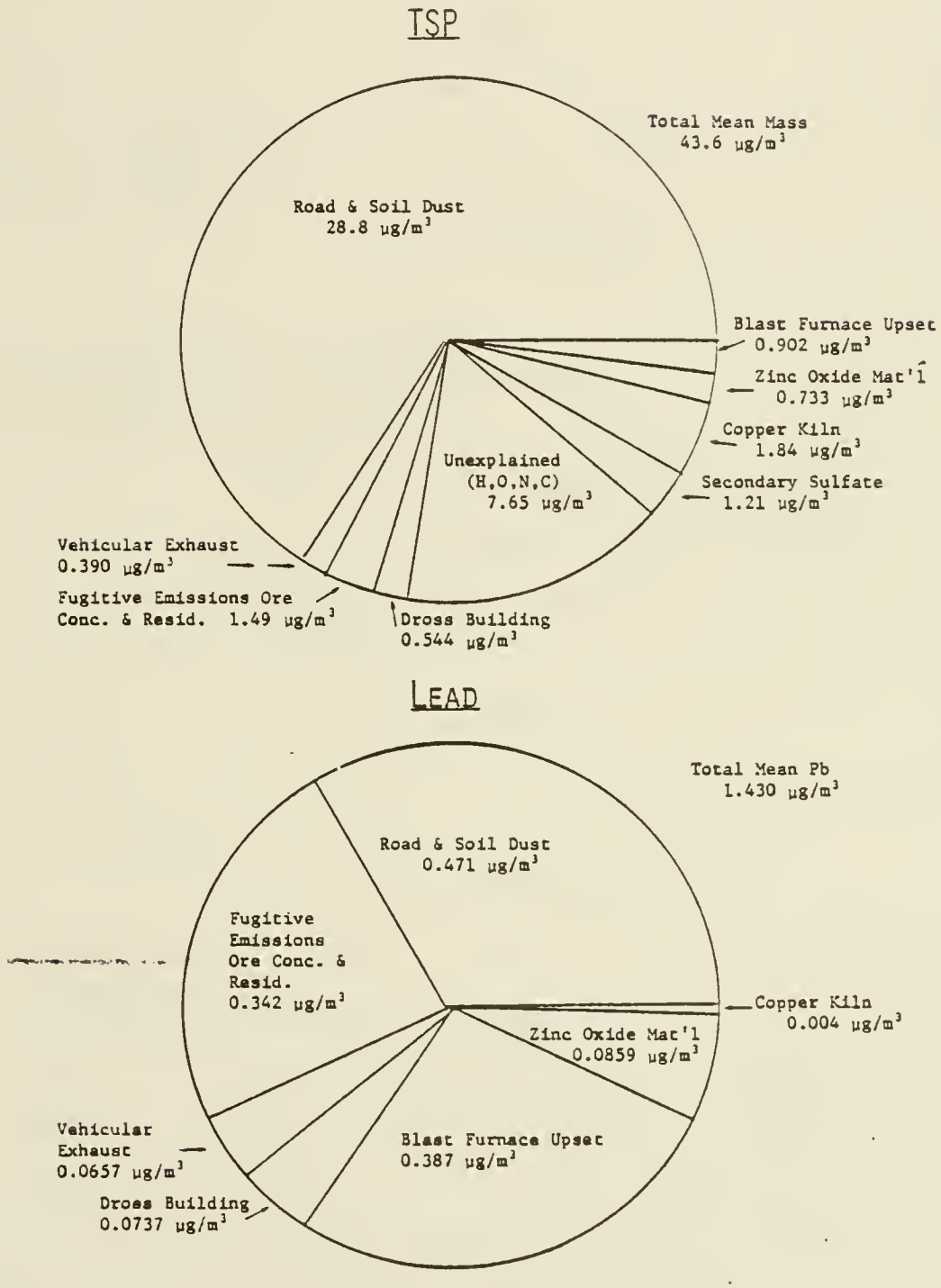
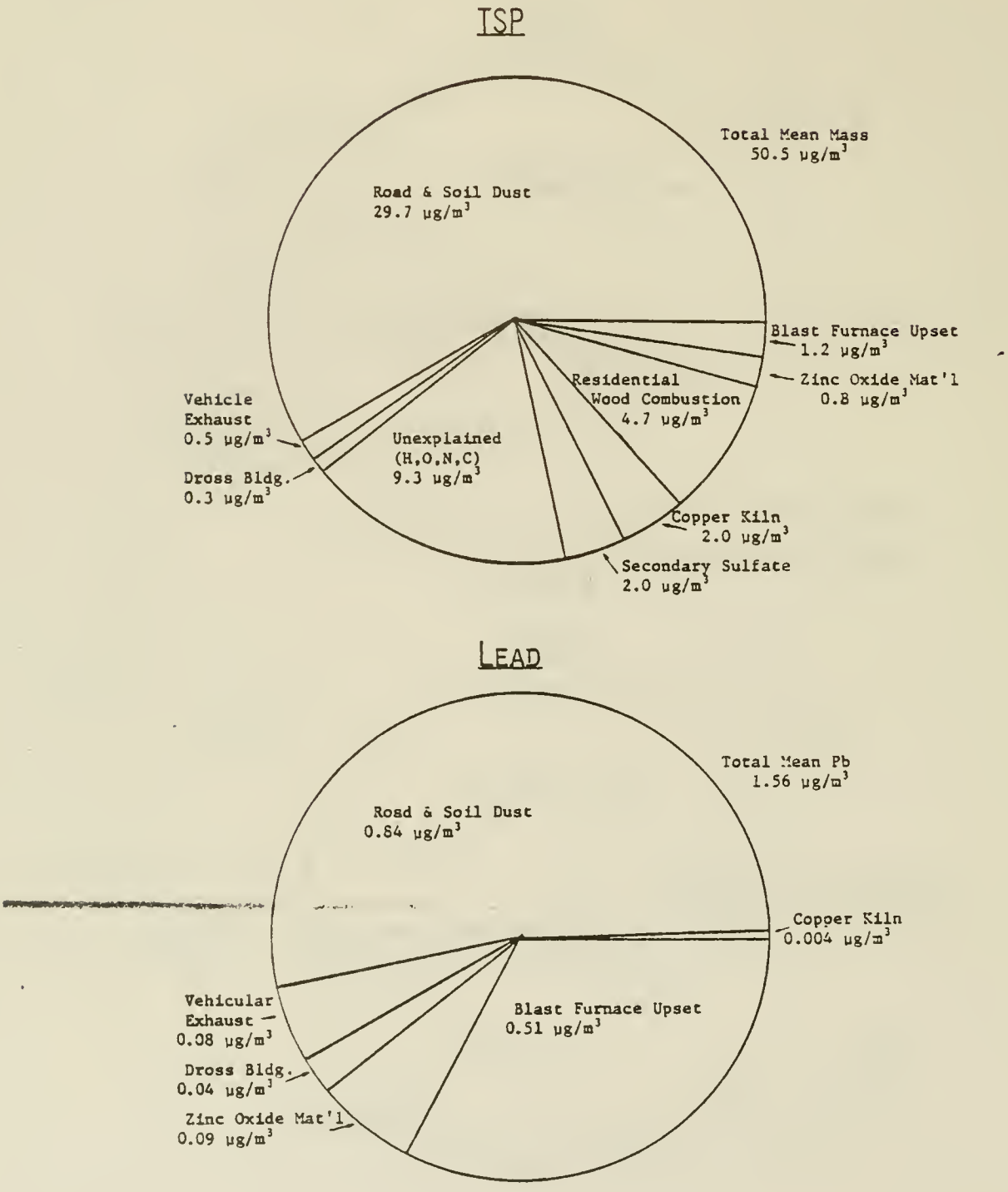


Figure 38

CMB Source Apportionment- Hadfield Site, 4th Quarter



hard to explain in the absence of any CMB data for the Dartman site and since a vector drawn from the smelter to the Dartman site would pass through the Hastie Residence site and not the Hadfield site.

The CMB analysis indicates that lead at the Hadfield site is primarily coming from the ASARCO blast furnace, road and soil dust, and in the case of the third quarter of 1981, fugitive emissions from ore piles and handling.

Total suspended particulate data at the Hadfield site correlated well with lead data from the same site. This is probably due to the fact that road and soil sources are major contributors to both lead and total suspended particulate.

The AQB, with the assistance of ASARCO, intends to continue to operate the Hadfield site for at least three additional years. The site is essential for SIP tracking, since it has recorded lead violations and apparently monitors different emission sources than the other sites, with the exception of the Dartman site.

8. The Dartman site is located in a field on the north edge of East Helena. It is approximately .5 miles north of the ASARCO smelter.

In 1982 insufficient data was collected at the Dartman site to establish any valid quarterly averages. However, some high individual readings were recorded. The reason for the poor data recovery was an unreliable power hookup. Recently the site has been moved a short distance and equipped with a separate power pole and meter base. The lead data from the Dartman site correlated poorly with data from all other East Helena lead sites except the Hadfield site. Therefore, it is not surprising that lead and TSP data from the Dartman site show a good correlation to data from the Hadfield site.

In light of these relationships, the AQB would normally recommend the closure of either the Hadfield or Dartman sites. However, due to the relatively high readings at both sites and the substantial distance between the locations, the Bureau will continue to operate both sites.

9. The South site is located .5 miles south southeast of the ASARCO smelter complex. During the original lead monitoring effort it was the only site which was not north of the smelter that showed ambient lead violations. The sampler is located in a field and surrounded by agricutural and pasture land.

   Lead data from the South site showed almost no correlation with lead data from other sites. In addition, the lead and TSP data at this site showed a very poor correlation. Apparently the sources of lead at the South site are totally different than the sources of TSP. The poor correlation with lead data from other sites may be caused by two factors: (1) the site is located in the opposite wind direction from the smelter in comparison to other sites, and (2) the major emission sources contributing to the filter catch are different from those at the other sites.

   The AQB will continue to operate the South site to track SIP progress, especially since this is the only site south of the smelter complex.

10. The Firehall site operated for two quarters in 1981. The AQB terminated sampling at this location during the summer of 1981 due to siting problems. During the time it operated, very high lead levels were recorded.

    Personnel from the ASARCO lead smelter have installed a new site at this location and intend to operate the site for at least three more years. The AQB will perform the filter analysis for lead.

SULFUR DIOXIDE (SO_2)

In 1982, the AQB monitored sulfur dioxide at Scobey, Billings, and Laurel, while the Missoula County Health Department monitored in Missoula. Table 30 lists the major sulfur dioxide sources throughout Montana.

East Helena

1. ASARCO operates SO_2 monitoring sites at California Street in Helena, the Water Tank west of the smelter, Kennedy Park in East Helena, the East Station, Kleffner Road, Kleffner Ranch, and Microwave. The AQB will continue to receive data from ASARCO and audit their network. These procedures should be adequate to track sulfur dioxide levels in East Helena.

Scobey

1. The AQB was monitoring SO_2 at two locations near Scobey (Figure 34) as part of the Poplar River Basin Environmental Impact Study. The sites were temporarily shut down in June of 1983 but will reopen sometime in late 1983 or early 1984. The locations are: the Border site, located on the Canadian Border north of Scobey and the Hanrahan site, 13 miles northeast of Scobey. The sites were originally established to gather baseline data prior to the startup of two 300 megawatt coal fired power generating units at Coronach, Saskatchewan and to monitor air quality impacts after startup. These sites were chosen as areas of highest SO_2 concentrations based on dispersion modeling performed by an AQB contractor.
2. During 1982 SO_2 concentrations remained very low at both sites. The maximum one-hour concentrations were 0.060 ppm at the Border site and 0.029 ppm at the Hanrahan site. These readings occurred during November

TABLE 30

POINT SOURCE SULFUR DIOXIDE EMISSION ESTIMATES FOR 1982

Source	SO_2 Tons/Yr	County	City
Exxon Co., USA	16313	Yellowstone	Billings
Montana Power Co. (Corette)	9811	Yellowstone	Billings
Farmers' Union CENEX	8233	Yellowstone	Laurel
Continental Oil Co.	3878	Yellowstone	Billings
Montana Sulfur	2130	Yellowstone	Billings
Great Western Sugar	855	Yellowstone	Billings
Westmoreland Resources	* 61	Big Horn	Hardin
East Decker Coal	* 42	Big Horn	Decker
Spring Creek Coal	* 27	Big Horn	Hardin
West Decker Coal	* 20	Big Horn	Decker
Simmons Refinery	1330	Cascade	Great Falls
WESTCO	1157	Glacier	Cut Bank
Union Oil of California	222	Glacier	Cut Bank
Rainbow Resources	203	Glacier	Browning
ASARCO	28740	Lewis & Clark	East Helena
Ideal Basic Industries	421	Gallatin	Trident
Kaiser Cement	335	Jefferson	Montana City
Anaconda Co. Butte Operations	* 50	Silver Bow	Butte
Montana Power Co. 1 and 2	5262	Rosebud	Colstrip
Oil and gas flaring	5000	Williston Basin**	
Montana Dakota Utilities	3843	Richland	Sidney
Shell Oil, gas plant	1163	Richland	Sidney
Perry Petrolane, gas plant	274	Richland	Sidney
American Colloid	63	Phillips	Malta
KENCO	55	Roosevelt	Wolf Point
Western Energy Coal	* 52	Rosebud	Colstrip
Peabody Coal	* 18	Rosebud	Colstrip
Anaconda Co. Aluminum	3551	Flathead	Columbia Falls
Champion Int., Packaging Div.	1432	Missoula	Frenchtown
W. R. Grace	109	Lincoln	Libby
Burlington Northern tie plant	42	Sanders	Paradise
Stoltze Land and Lumber	42	Ravalli	Darby
St. Regis Paper	33	Lincoln	Libby

*Includes tailpipe emissions from diesel powered vehicles.
**Estimated emissions for oil field gas flaring in the Williston Basin.

at the Hanrahan site and September at the Border site. The first 300 megawatt unit started up in October of 1980 and the second commenced operation in July of 1983.

3. The Montana Legislature appropriated sufficient funds to continue SO_2 monitoring in the Scobey area until July 1, 1983. State funding beyond July 1, 1983 has been appropriated for one final year commencing after both power generating units have reached rated capacity. Therefore, the monitoring sites have been temporarily shut down. The AQB anticipates that they will reopen in late 1983 or early 1984.

Billings and Laurel

1. Sulfur dioxide monitoring has been conducted in Billings and Laurel since 1974. In 1978, the Laurel area was designated non-attainment for the primary national ambient air quality standard for SO_2. Subsequently a stipulation was signed between the Department and the major sulfur dioxide emitting industries (see Figures 29 and 30) in the vicinity of Billings and Laurel. The stipulation provided for a one-year study to more fully describe the magnitude and geographical extent of sulfur dioxide concentrations. Another major goal of the study was to identify the relative source contribution from each industry.
2. Due to numerous delays, the study did not get underway until September of 1981. Through a cooperative effort, the affected industries and the AQB designed and installed an entirely new SO_2 sampling network. The air monitoring portion of the study was completed by GeoResearch Inc. of Billings on subcontract to Rockwell International and by the AQB. GeoResearch, Inc. operated the Coburn Road, Lockwood Park, North Johnson Lane, and Laurel BN sites, while the AQB operated the others (see

Figures 29 and 30). The air monitoring portion of the study was completed in September of 1982. However, the data analysis and source apportionment are continuing.

3. In the 1982 Network Review the AQB described in detail the monitoring sites associated with the study. Upon completion of the study in September of 1982, the AQB assumed the responsibility for operating all of the sites and was forced to shut down several of them due to time and financial restraints. Both Laurel sites, as well as the Shawnee Park and Fairgrounds sites, were eliminated.
4. A summary of 1982 sulfur dioxide data for Laurel and Billings is presented in Table 31. Only the Taft School, Lockwood Park, North Johnson Lane, and Coburn Road sites were operated over the entire year.

All of the Billings and Laurel monitoring sites were in compliance with the federal ambient air quality standards for sulfur dioxide. The Lockwood Park site exceeded the federal three-hour and the federal twenty-four hour standards once each, but the standard allows for one exemption per year. The North Johnson Lane site also recorded one three-hour concentration over the federal standard but again one exemption is allowed. Federal compliance policy presently mandates that "for a 24-hour violation to exist, it must occur from midnight to midnight of any given calendar day, and for a violation of an annual standard to occur, monthly means must be summed and averaged for that calendar year (January through December)."

The Montana standard for a twenty-four hour running average (0.10 ppm) was exceeded four times at North Johnson Lane, three times at Lockwood Park, and four times at Coburn Road. The highest twenty-four hour running average (0.173 ppm) occurred at the Lockwood Park site in December of 1982.

TABLE 31

SUMMARY OF 1982 SULFUR DIOXIDE DATA
FOR BILLINGS AND LAUREL MONITORING SITES

Site	1-hour Max.	3-hour Max.	Running 24-hour max.	Daily Max.	Annual Mean
Shawnee Park	0.421	0.198	0.085	0.080	*0.018(9)
North Johnson Lane	0.716	0.518	0.132	0.101	0.020(12)
Lockwood Park	0.663	0.600	0.173	0.157	0.023(12)
Fairgrounds (Metra)	0.174	0.143	0.039	0.039	*0.006(4)
Coburn Road	0.541	0.398	0.155	0.139	*0.027(12)
Taft School	0.264	0.200	0.068	0.065	*0.015(11)
Laurel BN	0.203	0.143	0.060	0.055	*0.009(9)
New Farm	0.110	0.082	0.040	0.036	*0.008(6)

*Insufficient data to constitute a valid annual average

( ) parentheses indicate number of sample months

The Montana sulfur dioxide standard for annual average (0.02 ppm) was violated at the North Johnson Lane and Lockwood Park sites. Although the Coburn Road site recorded an annual average of 0.027 ppm, there was no data for November and therefore the calendar annual average is invalid for compliance purposes.

The Montana one-hour standard of 0.50 ppm was exceeded once at the North Johnson Lane site, five times at the Lockwood Park site, and once at the Coburn Road site. None of these exceedances constituted a violation, since eighteen exemptions of the standard are allowed per year.

5. The Coburn Road site is located on the top of a ridge which separates the city of Billings from the Lockwood area. The Conoco oil refinery, the Montana Power Corette Plant, and the Great Western Sugar refinery are sulfur dioxide sources which are located on the Billings side of the ridge within two miles of the monitoring site. On the other side of the ridge in Lockwood are the Exxon Oil refinery and the Montana Sulphur and Chemical Company. Both of these SO_2 sources are approximately two miles northeast of the Coburn Road site.

   The site is at an elevation of 3380 feet MSL or approximately 280 feet above the surface of the Yellowstone valley. Wind patterns at the Coburn Road site are somewhat different than at the other sites located within the valley. In general, the wind speed is 0.5 to 1.0 meters per second faster with a much greater predominance from the west southwest. Apparently terrain features have much less effect on wind at the Coburn Road site.

   In 1982, the mean sulfur dioxide concentration at Coburn Road was the highest in the state. The Coburn Road monitor also recorded significant short-term levels of SO_2. Figures 39, 40, 41 and 42 show the diur-

nal distributions of sulfur dioxide concentrations at Coburn Road for November of 1981 and January, May, and August of 1982. It can be observed from these plots that winter concentrations are higher than summer and that regardless of season, the peak concentrations generally occur between 7:00 and 11:00 a.m.

From September 1981 through September 1982 GeoResearch operated an acoustic radar and released pilot balloons with temperature sondes from the Vo-Tech area west of Billings. The Bureau reviewed this data for each twenty-four hour sulfur dioxide episode over .10 ppm and made the following observations:

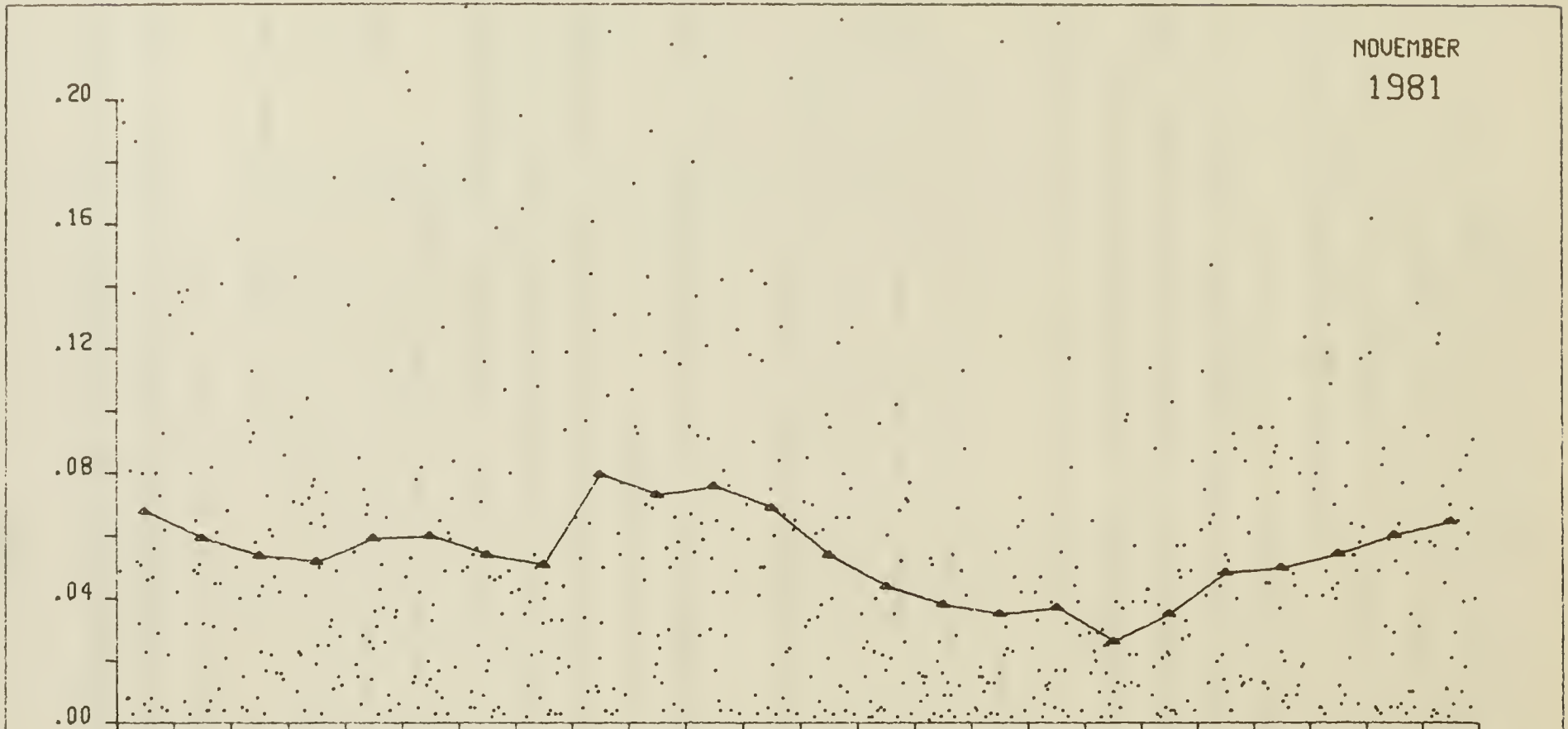
a. There are two general types of episodes at Coburn Road. Those occurring with light northeast wind eight to thirty-six hours after the passage of an arctic front and those occurring under relatively clear skies, warm temperatures, high pressure and west southwest winds.

b. Almost all high readings occurred during periods when double layered temperature inversions were present.

In light of this information, the AQB suspects that high sulfur dioxide concentrations at Coburn Road are originating from SO_2 sources in the Billings area as well as from Lockwood. This suspicion is reinforced by the sulfur dioxide concentration rose developed by Rockwell International and presented in Figure 43. This is a plot which displays the average concentration observed when winds are from each of the sixteen standard wind directions. In other words, the plot is normalized for wind frequency.

The AQB suspects that the elevation of the Coburn Road site is optimum so that during periods of multiple layered inversions the plumes of

figure 39



	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23
NUM-OBS	30	30	30	30	30	30	30	30	30	30	30	29	29	29	29	28	29	30	30	30	30	30	30	30
1-HIGH	.265	.235	.235	.175	.255	.209	.230	.195	.305	.218	.245	.275	.226	.350	.365	.219	.225	.099	.114	.147	.124	.128	.283	.333
2-HIGH	.200	.141	.155	.143	.244	.203	.174	.165	.264	.190	.214	.207	.127	.102	.113	.124	.117	.097	.103	.113	.104	.119	.239	.265
HR.AVG	.068	.059	.054	.052	.059	.060	.054	.051	.080	.073	.076	.069	.054	.044	.038	.035	.037	.026	.035	.048	.050	.055	.060	.065

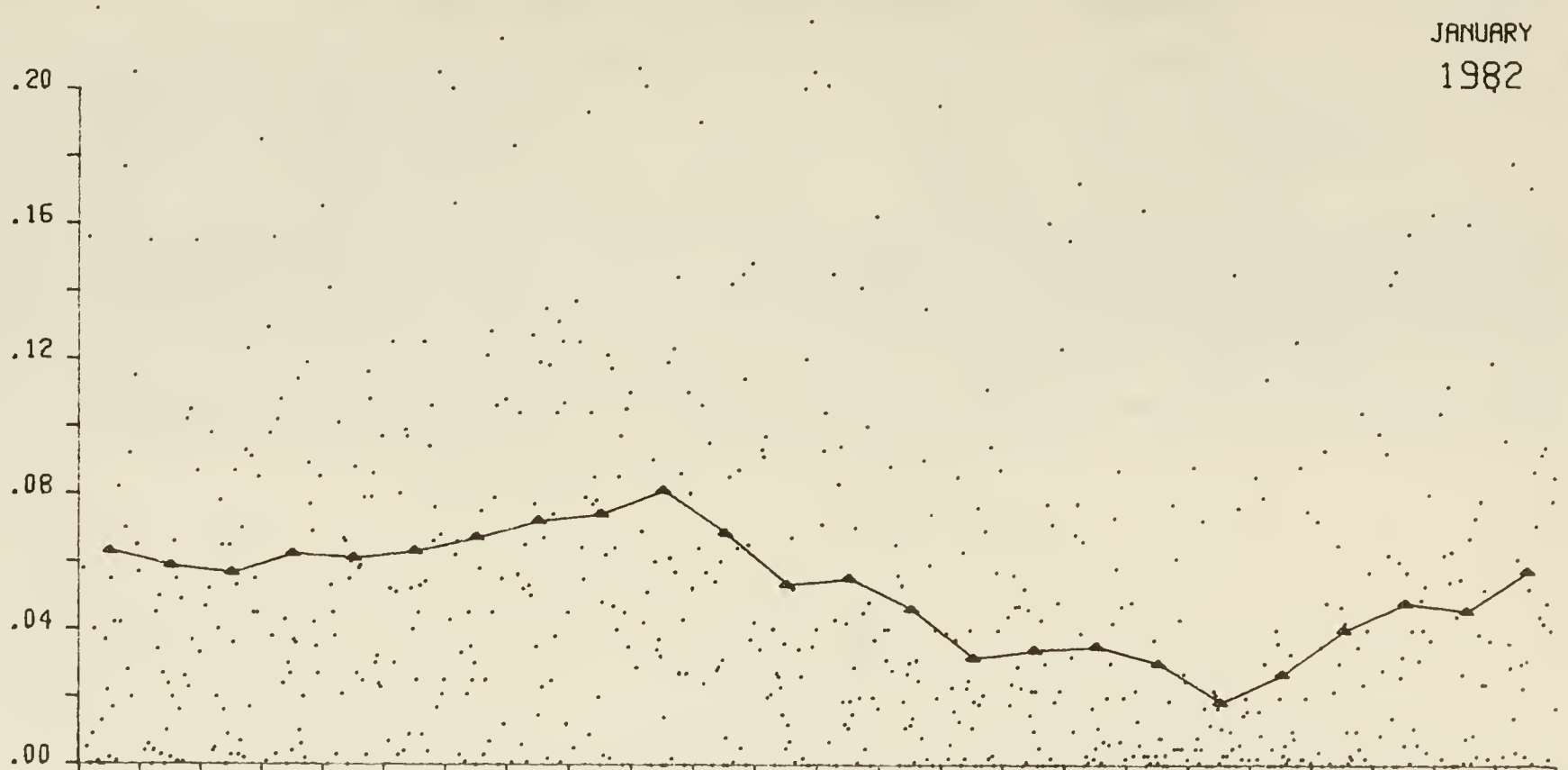
PLOT. . . . . CONCENTRATION VERSUS TIME (MON-SUN)
METHOD . . . . . PULSED FLUORESCENT
UNITS . . . . . PARTS PER MILLION
STANDARDS . . . (STATE) .50 PPM 1-HR AVG

PARAMETER . . SULFUR DIOXIDE
AREA. . . . . 0080, YELLOWSTONE CO
SITE. . . . . 066, COBURN ROAD
CITY. . . . . BILLINGS

MONTANA STATE AIR QUALITY BUREAU

APRIL 1983 TECHNICAL SERVICES

Figure 40



	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23
NUM-OBS	30	31	31	31	30	30	31	31	31	31	29	29	30	31	31	31	30	29	31	30	29	30	31	30
1-HIGH	.259	.392	.260	.241	.254	.256	.250	.285	.284	.359	.304	.220	.201	.237	.111	.160	.172	.280	.145	.125	.409	.163	.200	.294
2-HIGH	.224	.290	.185	.165	.141	.205	.215	.183	.193	.357	.190	.205	.162	.195	.094	.123	.155	.164	.088	.114	.104	.157	.160	.178
HR.AVG	.063	.059	.057	.062	.061	.063	.067	.072	.074	.081	.068	.053	.055	.046	.032	.034	.035	.030	.019	.027	.040	.048	.046	.058

PLOT. . . . . CONCENTRATION VERSUS TIME (MON-SUN)
METHOD . . . . . PULSED FLUORESCENT
UNITS . . . . . PARTS PER MILLION
STANDARDS . . . (STATE) .50 PPM 1-HR AVG

PARAMETER . . SULFUR DIOXIDE
AREA. . . . . 0080, YELLOWSTONE CO
SITE. . . . . 066, COBURN ROAD
CITY. . . . . BILLINGS

MONTANA STATE AIR QUALITY BUREAU

APRIL 1983

TECHNICAL SERVICES

Figure 41

	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23
NUM-OBS	28	27	27	28	28	28	28	28	27	25	26	25	25	24	26	26	27	28	28	28	28	27	28	29
1-HIGH	.025	.022	.021	.032	.026	.210	.065	.105	.111	.115	.039	.010	.015	.013	.011	.008	.019	.032	.035	.032	.044	.026	.020	.019
2-HIGH	.023	.021	.021	.024	.025	.079	.042	.079	.046	.047	.031	.009	.009	.006	.006	.006	.004	.012	.011	.031	.010	.023	.018	.018
HR.AVG	.005	.006	.005	.008	.008	.021	.013	.016	.016	.013	.008	.003	.003	.002	.002	.002	.002	.003	.003	.004	.003	.004	.005	.005

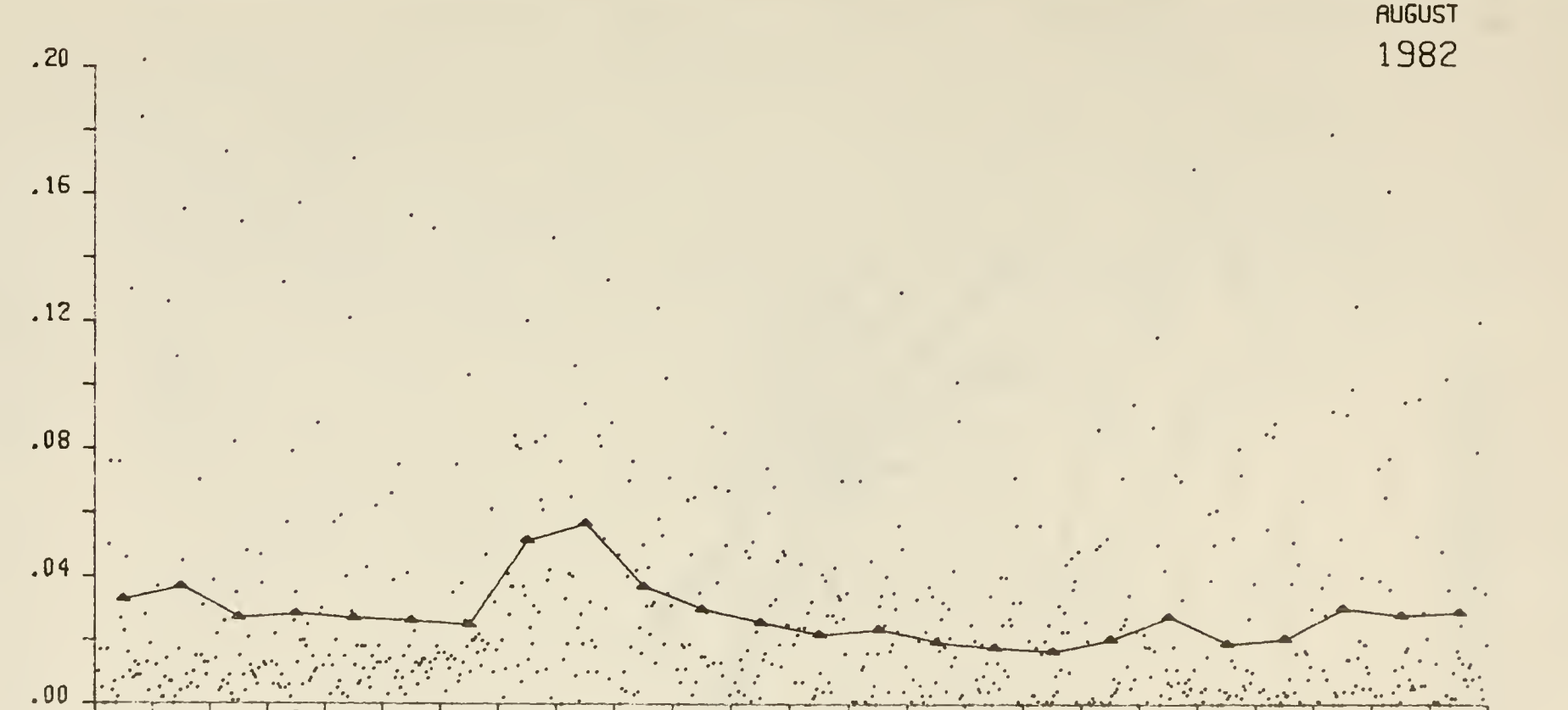
PLOT. . . . . CONCENTRATION VERSUS TIME (MON-SUN)
METHOD . . . . . PULSED FLUORESCENT
UNITS . . . . . PARTS PER MILLION
STANDARDS . . . (STATE) .50 PPM 1-HR AVG

PARAMETER . . SULFUR DIOXIDE
AREA. . . . . 0080, YELLOWSTONE CO
SITE. . . . . 066, COBURN ROAD
CITY. . . . . BILLINGS

MONTANA STATE AIR QUALITY BUREAU

APRIL 1983 TECHNICAL SERVICES

Figure 42



	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23
NUM-OBS	31	31	31	31	31	31	31	31	29	29	27	30	31	30	31	31	31	31	31	31	31	31	31	31
1-HIGH	.202	.385	.173	.157	.171	.153	.103	.307	.270	.124	.087	.074	.070	.129	.101	.071	.056	.094	.168	.080	.088	.179	.161	.253
2-HIGH	.184	.155	.151	.132	.121	.149	.075	.146	.243	.102	.085	.068	.044	.070	.089	.056	.048	.086	.115	.072	.085	.125	.096	.120
HR.AVG	.033	.037	.027	.028	.027	.026	.025	.051	.057	.037	.030	.026	.022	.024	.020	.018	.017	.021	.027	.019	.021	.030	.028	.029

PLOT. . . . . CONCENTRATION VERSUS TIME (MON-SUN)
METHOD . . . . . PULSED FLUORESCENT
UNITS . . . . . PARTS PER MILLION
STANDARDS . . . (STATE) .50 PPM 1-HR AVG

PARAMETER . . SULFUR DIOXIDE
AREA. . . . . 0080, YELLOWSTONE CO
SITE. . . . . 066, COBURN ROAD
CITY. . . . . BILLINGS

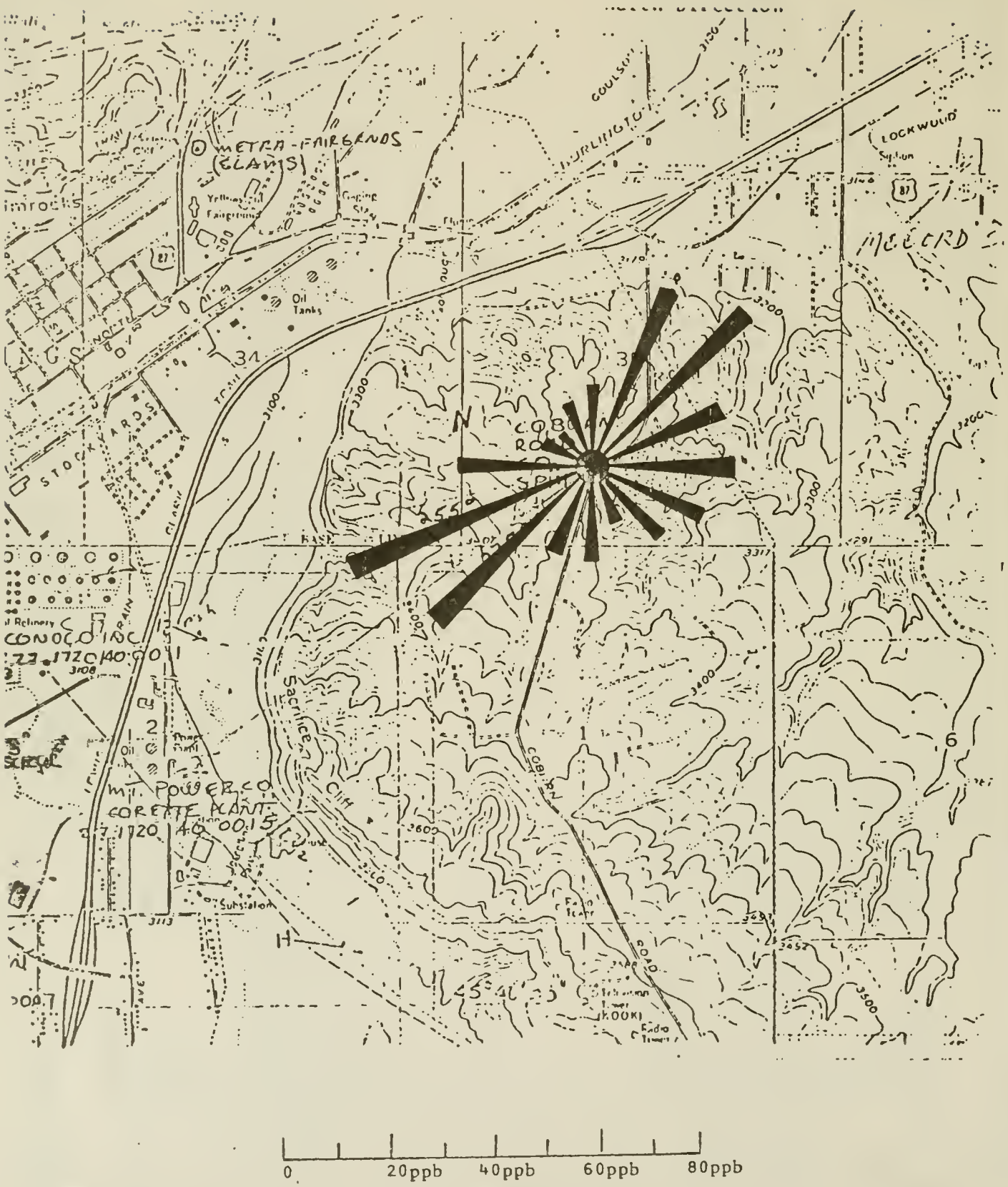
MONTANA STATE AIR QUALITY BUREAU

APRIL 1983

TECHNICAL SERVICES

Figure 43

TOTAL ANNUAL WIND DISTRIBUTION OF
SO_2 FOR THE COBURN ROAD STATION



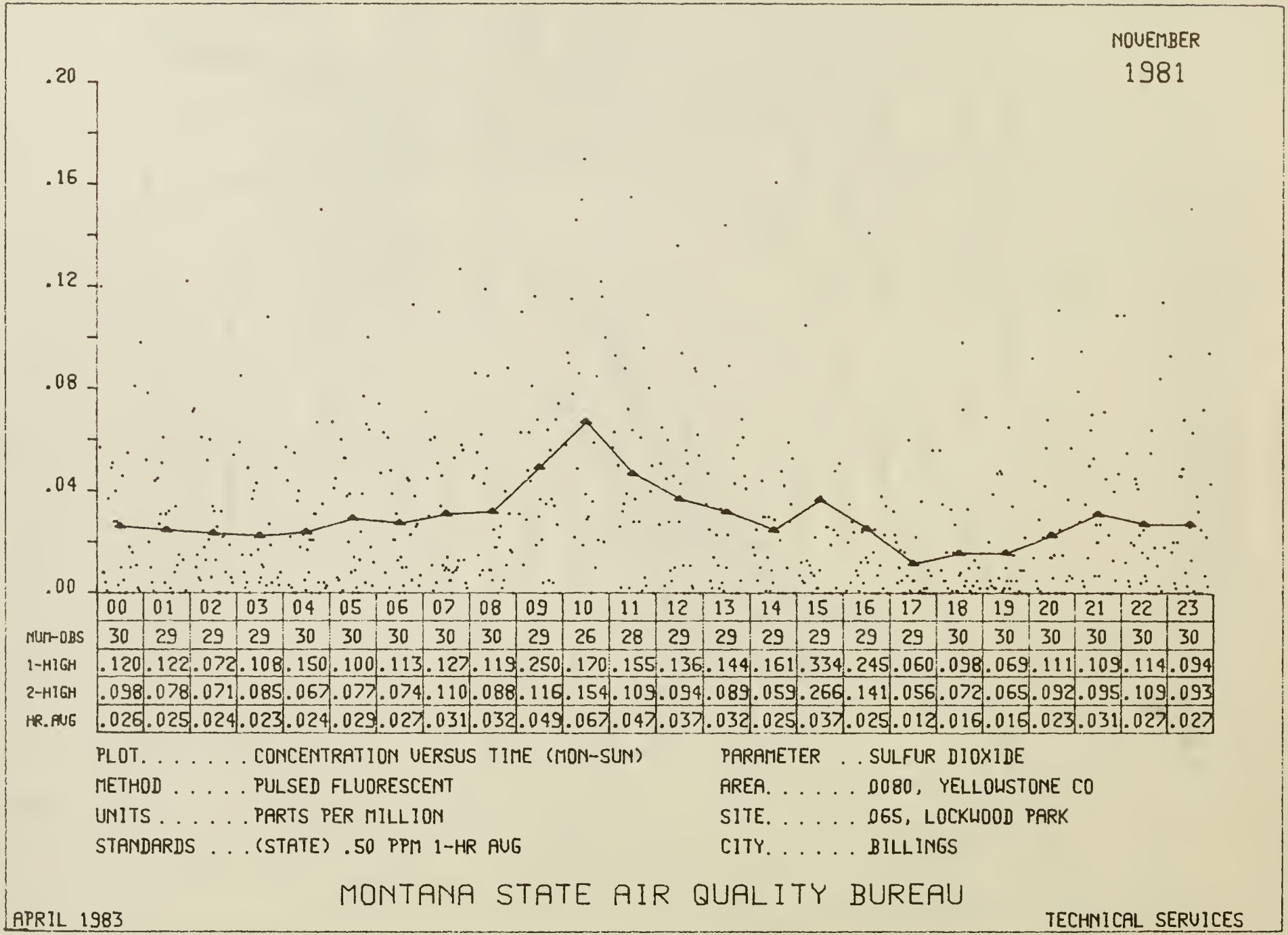
the various sources are trapped in a layer at the same height. This might explain why sulfur dioxide concentrations at Coburn Road are generally higher and often do not follow the concentrations at the other valley locations.

Since Coburn Road consistently records high sulfur dioxide concentrations, the AQB intends to continue to monitor sulfur dioxide at this location. In addition, the Bureau intends to redesignate the site as a SLAMS site instead of an SPM.

6. The Lockwood Park site is located in the northwest corner of the Lockwood Little League Park. The site is near the center of the Lockwood area and approximately 0.5 miles south southeast of the Exxon Refinery and the Montana Sulphur and Chemical Company. The Billings area sulfur dioxide sources lie 3.5 miles to the southwest over the ridge that the Coburn Road site lies on. Emissions from the Billings sources must either rise over the ridge or go north around the ridge and west through a constriction in the Yellowstone Valley. Winds at the Lockwood Park site averaged 2.4 meters per second in 1982. The predominant wind direction is from the south to the west southwest with a secondary predominance from the northeast.

   The Lockwood Park site recorded the highest 24-hour floating average and daily average for SO_2 for the entire state in 1982. The concentrations were 0.173 ppm and 0.157 ppm respectively. Figures 44, 45, 46 and 47 display diurnal plots of sulfur dioxide concentrations at the Lockwood Park site for November of 1981 and January, May, and August of 1982. Similar to the Coburn Road site, the peak concentrations occur during the daylight hours, usually between 9:00 a.m. and 12 noon.

Figure 44



	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23
NUM-OBS	30	29	29	29	30	30	30	30	30	29	26	28	29	29	29	29	29	29	30	30	30	30	30	30
1-HIGH	.120	.122	.072	.108	.150	.100	.113	.127	.119	.250	.170	.155	.136	.144	.161	.334	.245	.060	.098	.069	.111	.109	.114	.094
2-HIGH	.098	.078	.071	.085	.067	.077	.074	.110	.088	.116	.154	.109	.094	.089	.059	.266	.141	.056	.072	.065	.092	.095	.109	.093
HR.AVG	.026	.025	.024	.023	.024	.029	.027	.031	.032	.049	.067	.047	.037	.032	.025	.037	.025	.012	.016	.016	.023	.031	.027	.027

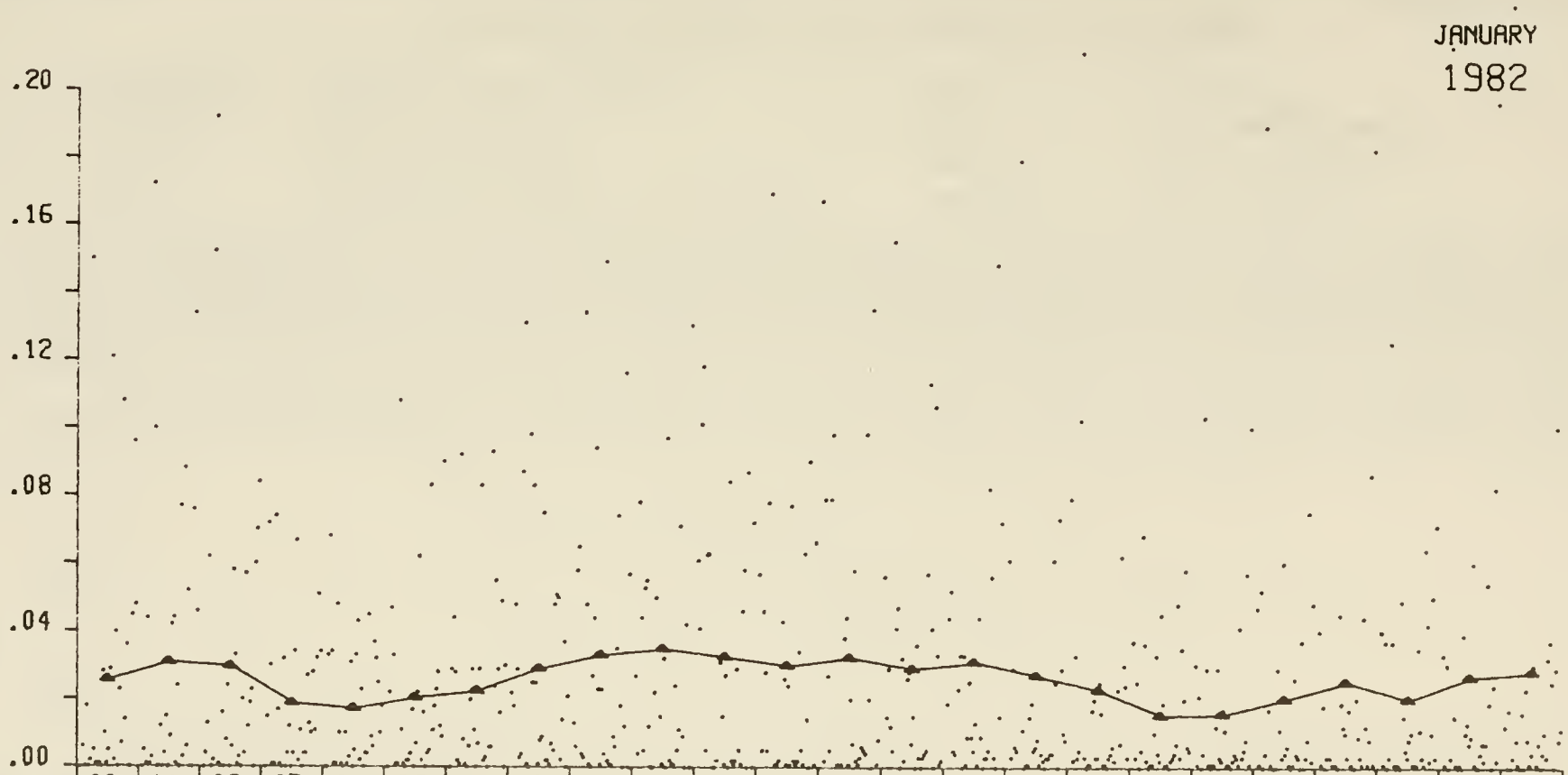
PLOT. . . . . CONCENTRATION VERSUS TIME (MON-SUN)
METHOD . . . . . PULSED FLUORESCENT
UNITS . . . . . PARTS PER MILLION
STANDARDS . . . (STATE) .50 PPM 1-HR AVG

PARAMETER . . SULFUR DIOXIDE
AREA. . . . . 0080, YELLOWSTONE CO
SITE. . . . . 065, LOCKWOOD PARK
CITY. . . . . BILLINGS

MONTANA STATE AIR QUALITY BUREAU

APRIL 1983 TECHNICAL SERVICES

Figure 45



	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23
NUM-OBS	31	31	31	31	31	31	31	31	31	31	28	28	28	30	31	31	30	31	31	31	31	31	31	31
1-HIGH	.150	.172	.192	.074	.068	.108	.093	.131	.149	.257	.118	.169	.167	.155	.249	.267	.211	.068	.103	.189	.243	.125	.213	.261
2-HIGH	.121	.134	.152	.072	.048	.090	.092	.098	.134	.130	.101	.090	.135	.113	.148	.179	.102	.058	.100	.075	.182	.071	.196	.225
HR.AVG	.026	.031	.030	.019	.017	.021	.023	.029	.033	.035	.033	.030	.033	.029	.031	.027	.023	.016	.016	.020	.025	.020	.027	.028

PLOT. . . . . CONCENTRATION VERSUS TIME (MON-SUN)
METHOD . . . . . PULSED FLUORESCENT
UNITS . . . . . PARTS PER MILLION
STANDARDS . . . (STATE) .50 PPM 1-HR AVG

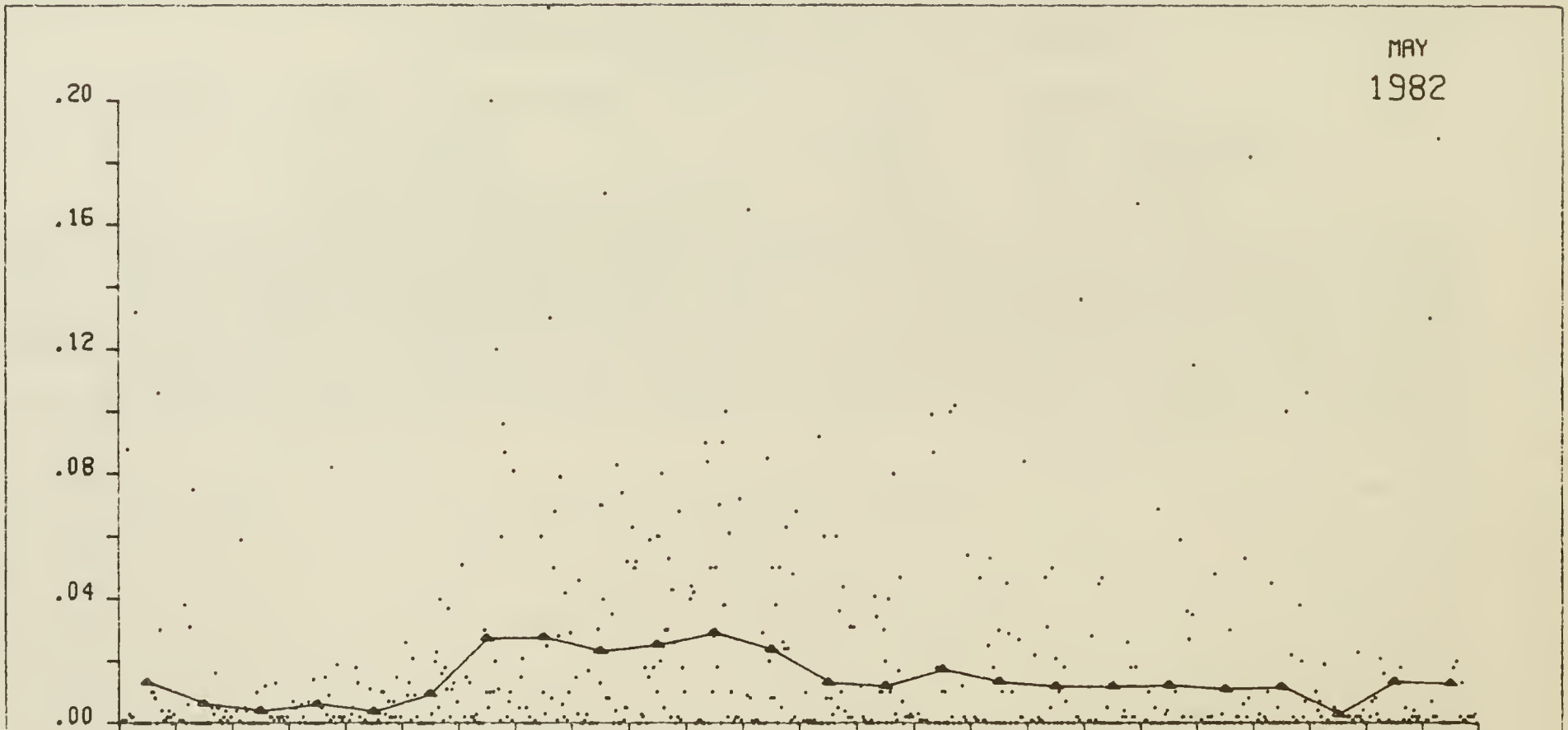
PARAMETER . . SULFUR DIOXIDE
AREA. . . . . 0080, YELLOWSTONE CO
SITE. . . . . 065, LOCKWOOD PARK
CITY. . . . . BILLINGS

MONTANA STATE AIR QUALITY BUREAU

APRIL 1983

TECHNICAL SERVICES

Figure 46



	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23
NUM-OBS	31	31	31	30	30	31	31	30	29	30	31	31	31	31	29	29	30	31	31	31	31	31	31	31
1-HIGH	.132	.075	.059	.082	.018	.040	.200	.230	.170	.080	.100	.165	.092	.080	.102	.084	.136	.167	.115	.182	.106	.023	.322	.188
2-HIGH	.106	.038	.013	.019	.015	.037	.120	.130	.083	.068	.090	.085	.060	.047	.100	.053	.050	.047	.069	.053	.100	.019	.021	.130
HR.AVG	.013	.006	.004	.006	.004	.010	.027	.028	.023	.025	.029	.024	.013	.012	.017	.013	.012	.012	.012	.011	.012	.003	.013	.013

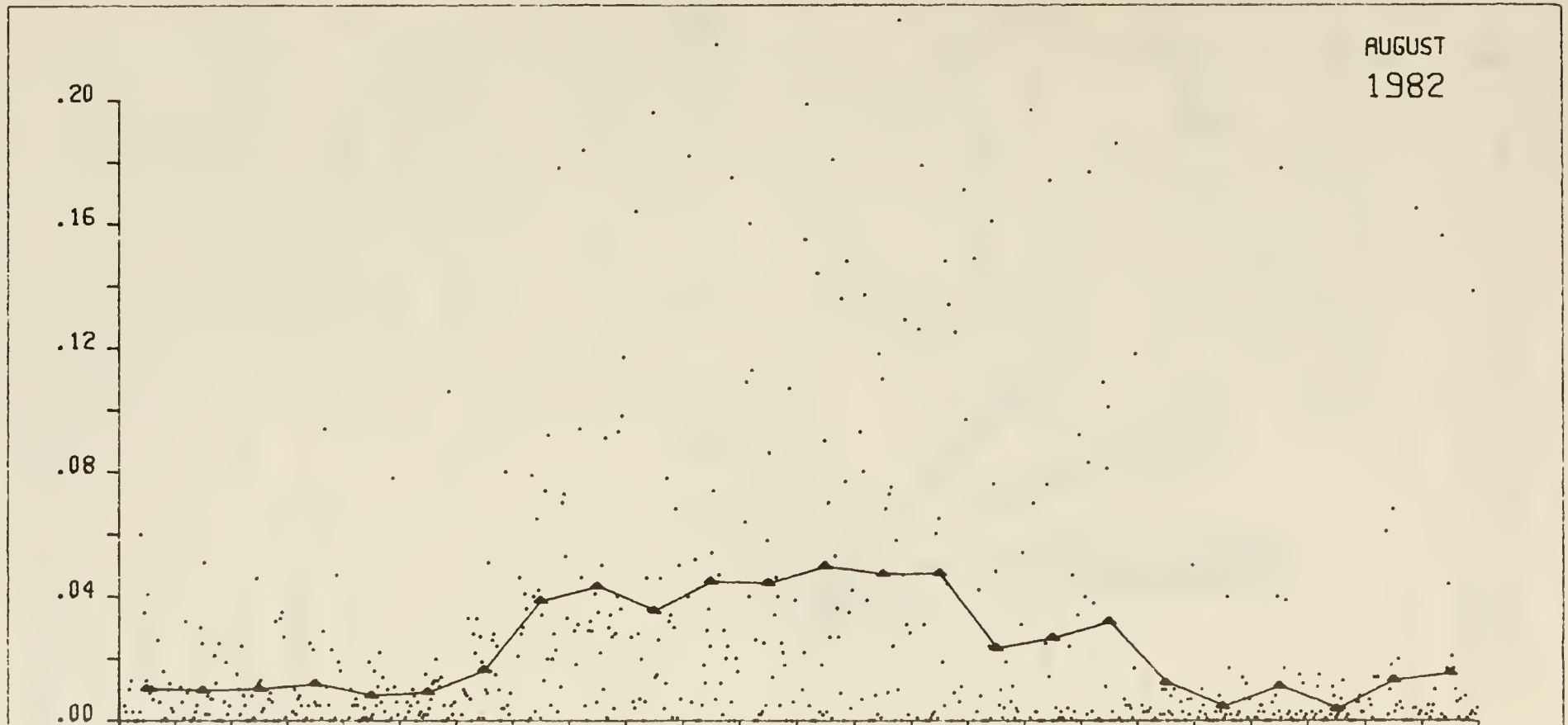
PLOT. . . . . CONCENTRATION VERSUS TIME (MON-SUN)
METHOD . . . . . PULSED FLUORESCENT
UNITS . . . . . PARTS PER MILLION
STANDARDS . . . (STATE) .50 PPM 1-HR AVG

PARAMETER . . SULFUR DIOXIDE
AREA. . . . . 0080, YELLOWSTONE CO
SITE. . . . . 065, LOCKWOOD PARK
CITY. . . . . BILLINGS

MONTANA STATE AIR QUALITY BUREAU

APRIL 1983 TECHNICAL SERVICES

Figure 47



	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23
NUM-OBS	30	30	30	30	30	30	30	30	29	28	30	30	30	29	26	28	29	31	31	31	31	31	31	31
1-HIGH	.060	.051	.046	.094	.078	.106	.080	.178	.184	.196	.242	.239	.199	.226	.179	.161	.197	.186	.243	.040	.178	.015	.165	.156
2-HIGH	.041	.032	.035	.047	.022	.020	.051	.092	.117	.164	.218	.160	.181	.137	.171	.149	.174	.177	.050	.017	.040	.013	.068	.138
HR.AVG	.010	.010	.010	.012	.008	.009	.016	.039	.043	.035	.045	.044	.050	.047	.048	.024	.027	.032	.012	.005	.011	.004	.013	.016

PLOT. . . . . CONCENTRATION VERSUS TIME (MON-SUN)
METHOD . . . . . PULSED FLUORESCENT
UNITS . . . . . PARTS PER MILLION
STANDARDS . . . (STATE) .50 PPM 1-HR AVG

PARAMETER . . SULFUR DIOXIDE
AREA. . . . . 0080, YELLOWSTONE CO
SITE. . . . . 065, LOCKWOOD PARK
CITY. . . . . BILLINGS

MONTANA STATE AIR QUALITY BUREAU

APRIL 1983 TECHNICAL SERVICES

Figure 48 was developed by Rockwell International as a part of the Billings sulfur dioxide study. It displays the average SO_2 concentrations observed when the winds are from each of the sixteen standard wind directions. In other words, the plot is normalized for wind frequency. The plot indicates that the highest concentrations are associated with north and northwest winds and to a lesser degree southwest winds. It appears that this site is being influenced by sulfur dioxide emissions from the Lockwood area sources and to a lesser degree but still significantly, from the Billings area sources.

The AQB suspects that emissions from the Billings sources are actually passing over Sacrifice Cliff and down into the Lockwood area instead of following the valley. This is at least partially substantiated by the lower concentrations observed at the Fairgrounds site. The Fairground site is located in the narrow portion of the Yellowstone Valley between Billings and Lockwood.

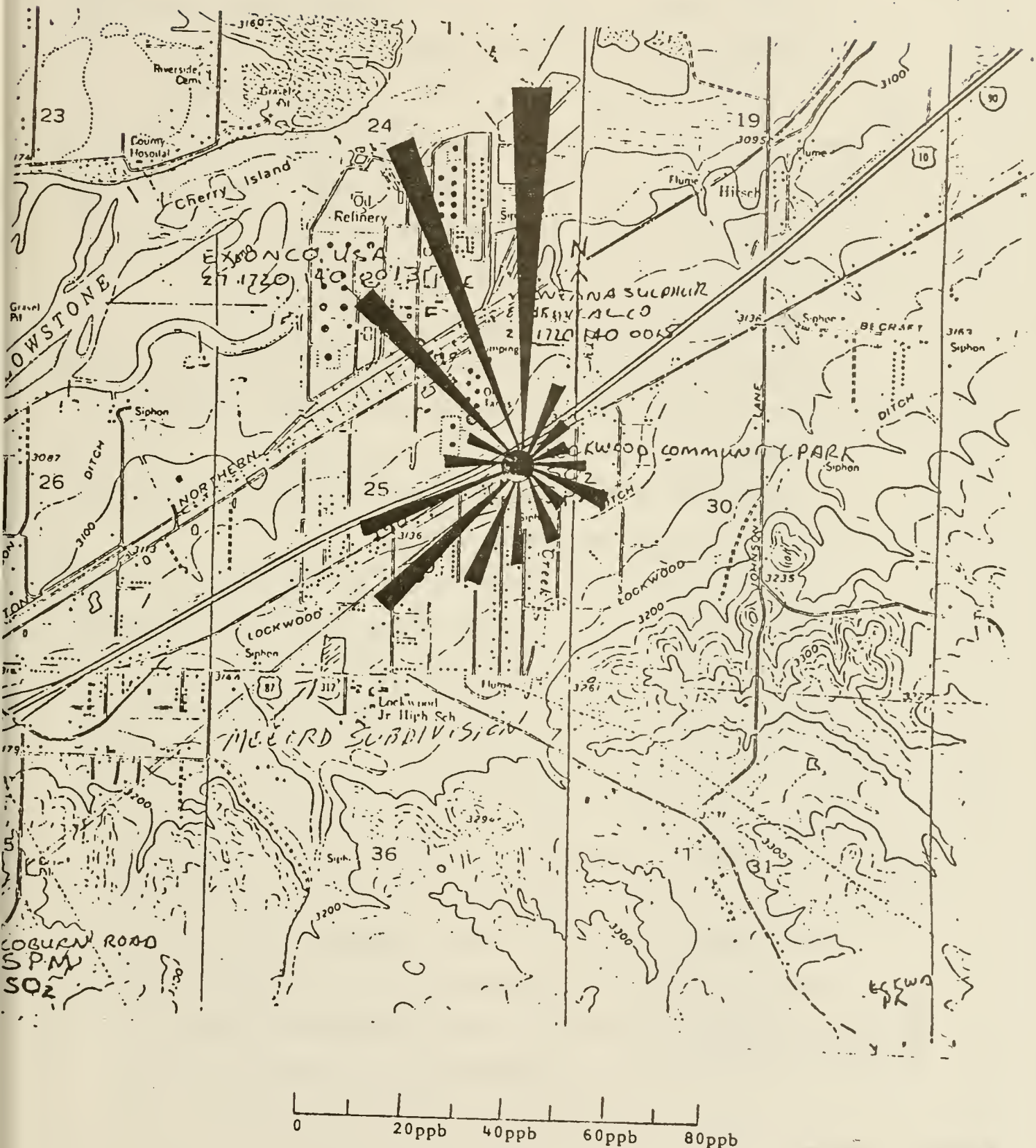
The AQB plans to continue to operate the Lockwood Park site and redesignate it a NAMS site for sulfur dioxide on January 1, 1984. The high sulfur dioxide readings and its location near the center of population for Lockwood make the site essential.

7. As part of the Billings SO_2 study, GeoResearch, Inc. operated an SO_2 monitoring site on North Johnson Lane. On September 26, 1982 the AQB took over the operation of the site and operated it until June of 1983. The site is temporarily shut down for the summer months (generally lower concentrations) due to manpower problems.

   The North Johnson Lane site is located in a field one mile northeast of the Exxon refinery and the Montana Sulfur and Chemical Company. It is also 4.5 miles northeast of the Billings area sulfur dioxide sources. The immediate area around the site is undeveloped with the exception of an asphalt batch plant 200 yards to the north.

Figure 48

TOTAL ANNUAL WIND DISTRIBUTION OF SO_2 FOR THE LOCKWOOD STATION



Winds at North Johnson Lane are predominantly from the southwest and to a lesser extent from the northeast. The average wind speed during 1982 was 2.8 meters per second. This is slightly higher than at Lockwood Park, but lower than Coburn Road.

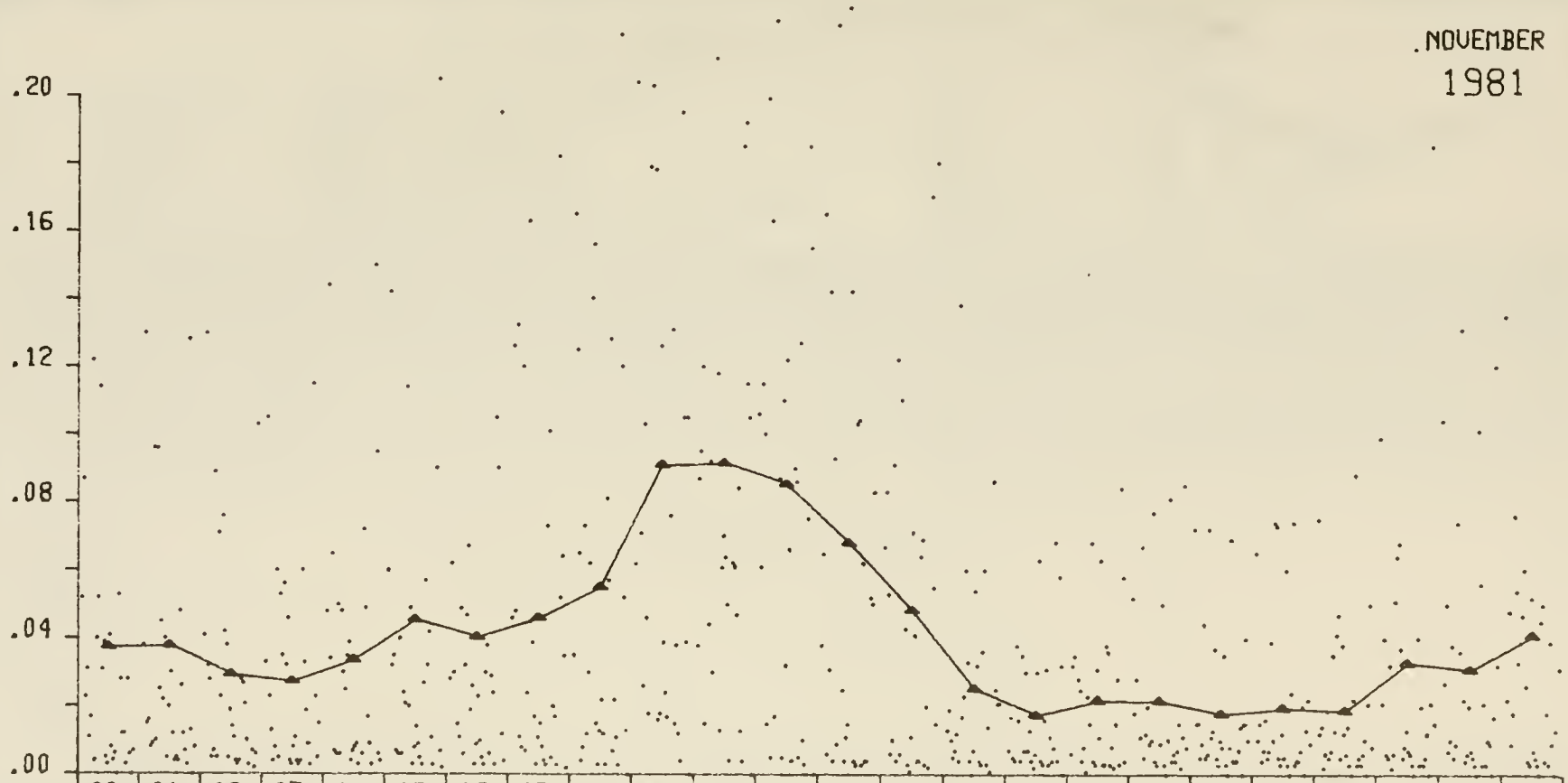
During 1982 the North Johnson Lane site registered the highest one-hour sulfur dioxide reading (0.716 ppm) for the entire state. High concentrations were also recorded for the three-hour and twenty-four hour time periods (see Table 31). In addition, the annual average concentrations for 1982 exceeded the Montana ambient standard.

Figures 49, 50, 51, and 52 show the diurnal distributions of sulfur dioxide concentrations at the North Johnson Lane site for November of 1981 and January, May and August of 1982. Again the highest concentrations occur in the morning from 8:00 a.m. to noon. It is also apparent that November of 1981 and August of 1982 had much higher concentrations than the other two months.

The concentrations rose (Figure 53) for North Johnson Lane developed by Rockwell International indicates that the higher SO_2 concentrations are associated with winds from the west southwest to the south southeast. Sulfur dioxide arriving at North Johnson Lane with these wind directions is probably coming from both the Lockwood and Billings areas. However, the Lockwood SO_2 sources are much closer to the site and are probably responsible for a much larger share of the impact.

The AQB temporarily shut down the North Johnson Lane site in June of 1983. The site will be reactivated in September of 1983 to monitor the high concentrations of SO_2 associated with the fall and winter months. The AQB intends to continue to operate the site as an SPM site, at least on a seasonal basis. If manpower becomes available, the site will return to year around operation.

Figure 49



	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23
NUM-OBS	30	30	29	29	29	30	30	30	30	29	29	29	28	27	28	30	29	29	30	30	30	30	30	30
1-HIGH	.290	.260	.130	.115	.150	.295	.235	.182	.218	.329	.417	.305	.238	.180	.138	.068	.084	.085	.072	.074	.088	.214	.131	.385
2-HIGH	.122	.130	.103	.105	.144	.205	.195	.163	.165	.260	.257	.222	.226	.170	.086	.063	.068	.081	.072	.074	.075	.185	.120	.135
HR.AVG	.038	.038	.029	.027	.034	.046	.041	.046	.055	.091	.092	.085	.068	.048	.025	.018	.022	.022	.018	.020	.019	.033	.031	.041

PLOT. . . . . CONCENTRATION VERSUS TIME (MON-SUN)
METHOD . . . . . PULSED FLUORESCENT
UNITS . . . . . PARTS PER MILLION
STANDARDS . . . (STATE) .50 PPM 1-HR AVG

PARAMETER . . SULFUR DIOXIDE
AREA. . . . . 0080, YELLOWSTONE CO
SITE. . . . . 064, NORTH JOHNSON LANE
CITY. . . . . BILLINGS

MONTANA STATE AIR QUALITY BUREAU

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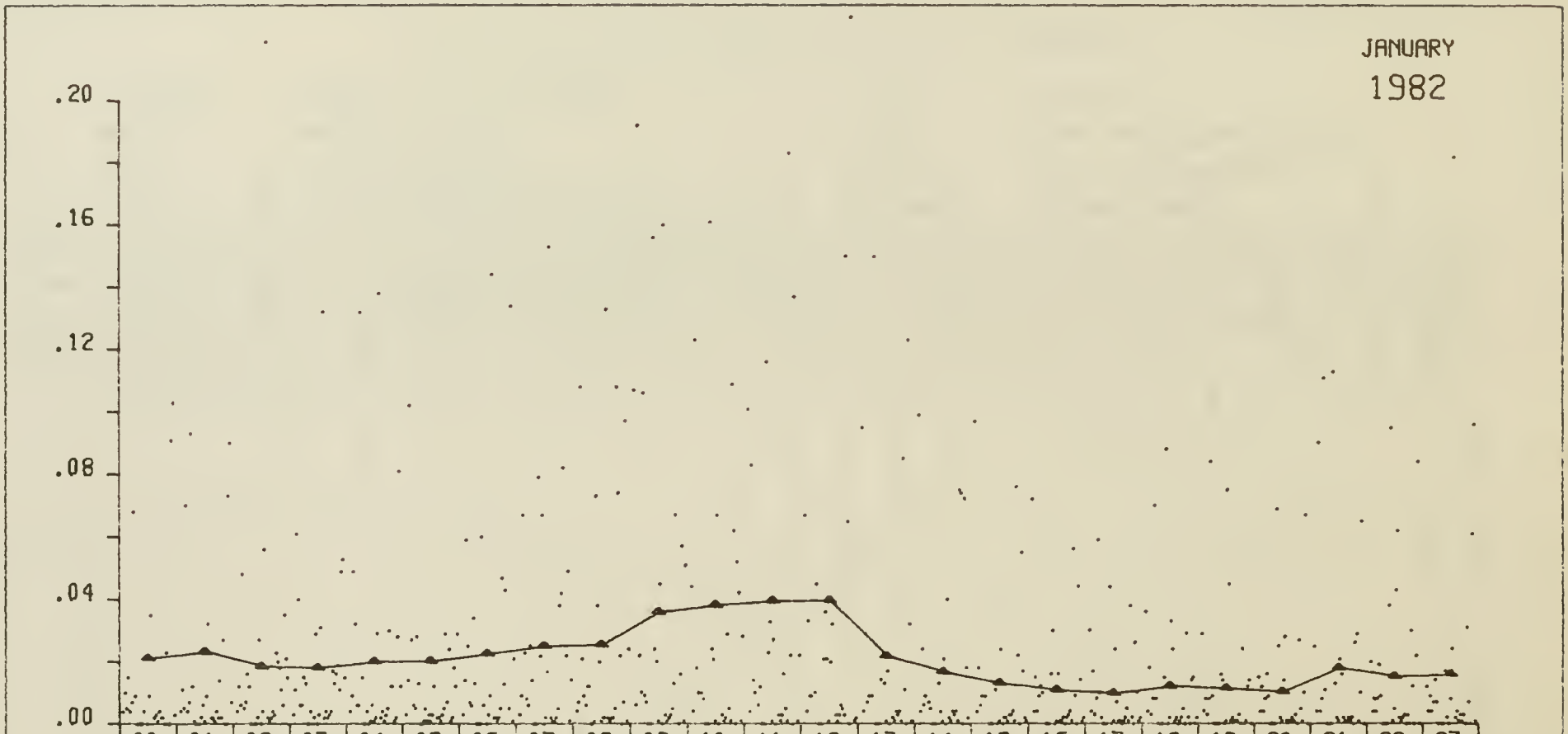
TECHNICAL SERVICES

Figure 50



	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23
NUM-OBS	31	31	31	31	31	31	30	30	31	30	30	29	29	29	29	28	30	31	31	31	31	31	31	31
1-HIGH	.236	.244	.219	.132	.138	.273	.144	.153	.133	.192	.328	.326	.381	.150	.099	.097	.072	.059	.088	.084	.069	.113	.095	.182
2-HIGH	.103	.093	.056	.061	.132	.102	.134	.082	.108	.160	.161	.183	.227	.123	.075	.076	.056	.044	.070	.075	.067	.111	.084	.096
HR.AVG	.021	.023	.019	.018	.020	.020	.023	.025	.026	.036	.038	.040	.040	.022	.017	.013	.011	.010	.012	.011	.011	.018	.015	.016

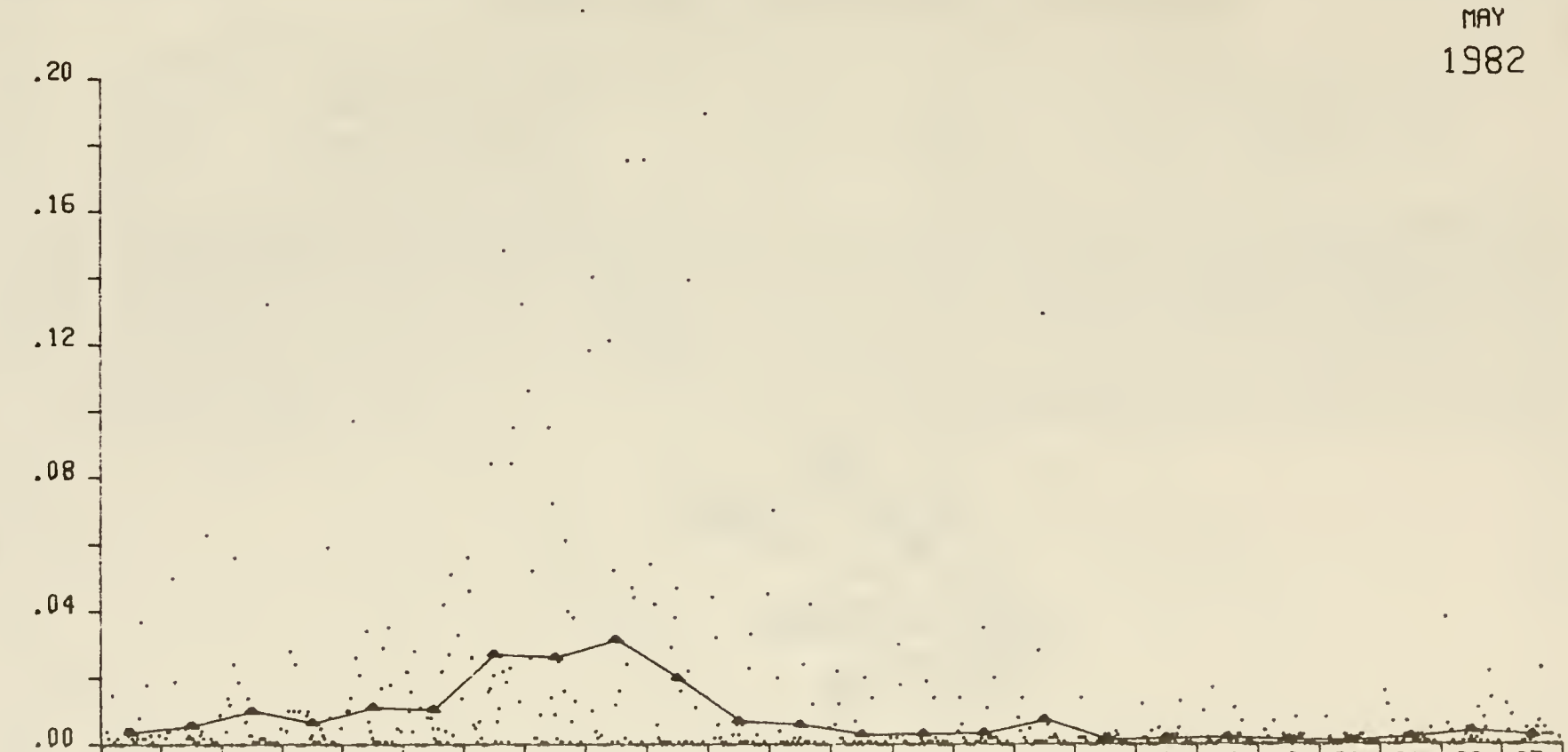
PLOT. . . . . CONCENTRATION VERSUS TIME (MON-SUN)
METHOD . . . . . PULSED FLUORESCENT
UNITS . . . . . PARTS PER MILLION
STANDARDS . . . (STATE) .50 PPM 1-HR AVG

PARAMETER . . SULFUR DIOXIDE
AREA. . . . . 0080, YELLOWSTONE CO
SITE. . . . . 064, NORTH JOHNSON LANE
CITY. . . . . BILLINGS

MONTANA STATE AIR QUALITY BUREAU

APRIL 1983 TECHNICAL SERVICES

Figure 51



	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23
NUM-OBS	31	31	30	30	30	31	31	31	30	30	30	31	31	29	30	28	29	31	31	31	31	31	31	31
1-HIGH	.037	.063	.132	.059	.097	.051	.148	.220	.175	.189	.045	.070	.022	.030	.035	.129	.014	.013	.017	.008	.008	.016	.038	.023
2-HIGH	.018	.050	.056	.028	.035	.042	.132	.106	.175	.139	.044	.042	.020	.019	.020	.028	.004	.012	.011	.007	.003	.012	.022	.012
HR.AVG	.004	.006	.010	.007	.011	.011	.027	.026	.032	.020	.007	.006	.003	.003	.004	.008	.002	.002	.002	.002	.001	.002	.004	.003

PLOT. . . . . CONCENTRATION VERSUS TIME (MON-SUN)
METHOD . . . . . PULSED FLUORESCENT
UNITS . . . . . PARTS PER MILLION
STANDARDS . . . (STATE) .50 PPM 1-HR AVG

PARAMETER . . SULFUR DIOXIDE
AREA. . . . . 0080, YELLOWSTONE CO
SITE. . . . . 064, NORTH JOHNSON LANE
CITY. . . . . BILLINGS

MONTANA STATE AIR QUALITY BUREAU

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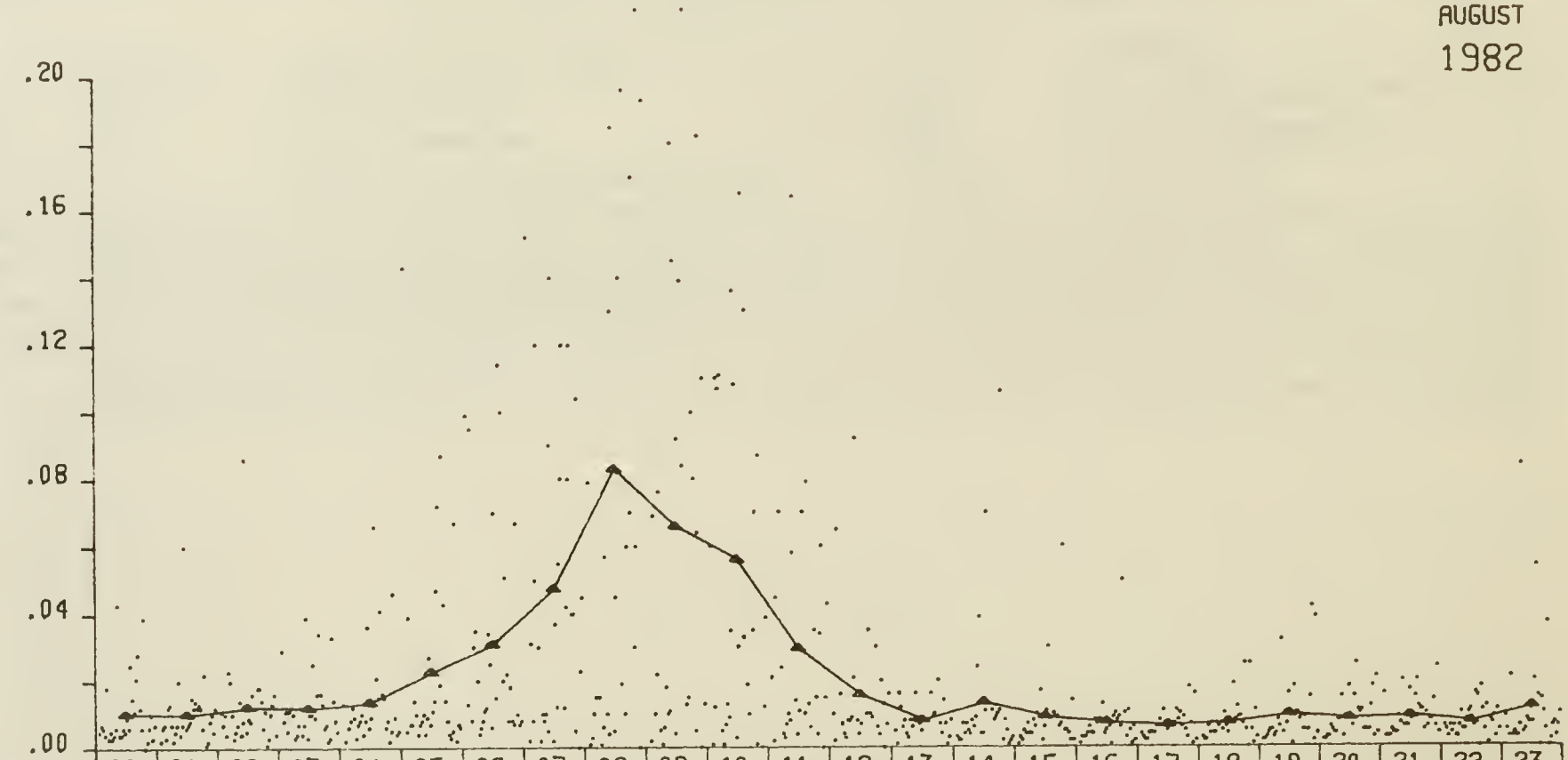
Figure 52



	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23
NUM-OBS	31	31	31	31	31	31	31	31	29	29	29	28	27	26	29	29	31	31	31	31	31	31	31	31
1-HIGH	.043	.060	.086	.039	.066	.143	.114	.152	.425	.234	.277	.164	.092	.020	.106	.060	.050	.018	.025	.042	.025	.024	.018	.084
2-HIGH	.039	.022	.023	.034	.046	.087	.100	.140	.250	.220	.165	.079	.065	.016	.070	.030	.013	.016	.025	.039	.021	.020	.016	.054
HR.AVG	.010	.010	.013	.012	.014	.023	.031	.048	.083	.066	.056	.030	.016	.008	.013	.009	.007	.006	.007	.010	.009	.009	.007	.012

PLOT. . . . . CONCENTRATION VERSUS TIME (MON-SUN)
METHOD . . . . . PULSED FLUORESCENT
UNITS . . . . . PARTS PER MILLION
STANDARDS . . . (STATE) .50 PPM 1-HR AVG

PARAMETER . . SULFUR DIOXIDE
AREA. . . . . 0080, YELLOWSTONE CO
SITE. . . . . 064, NORTH JOHNSON LANE
CITY. . . . . BILLINGS

MONTANA STATE AIR QUALITY BUREAU

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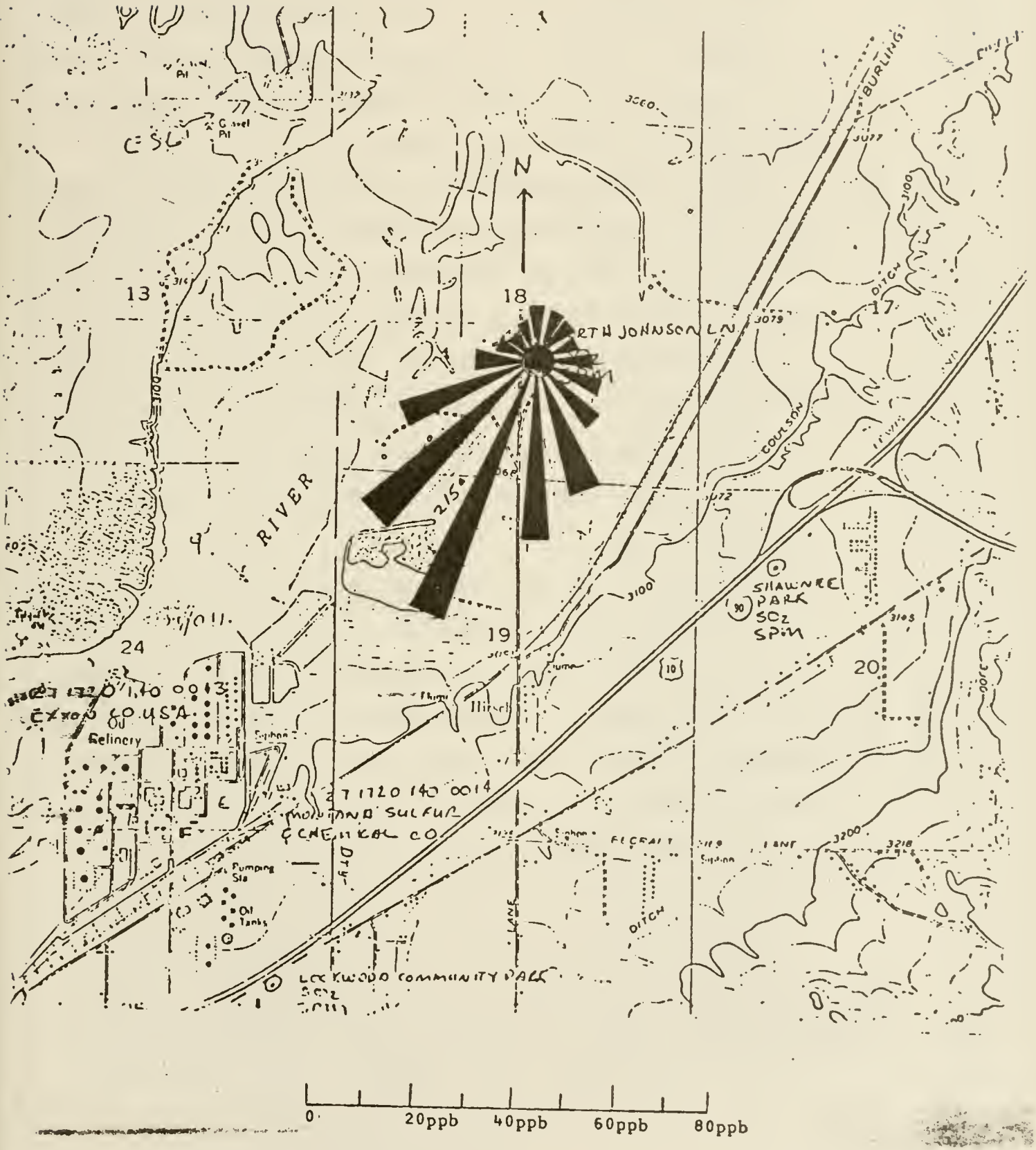
Figure 53

TOTAL ANNUAL WIND DISTRIBUTION OF SULFUR DIOXIDE

FOR THE NORTH JOHNSON LANE STATION



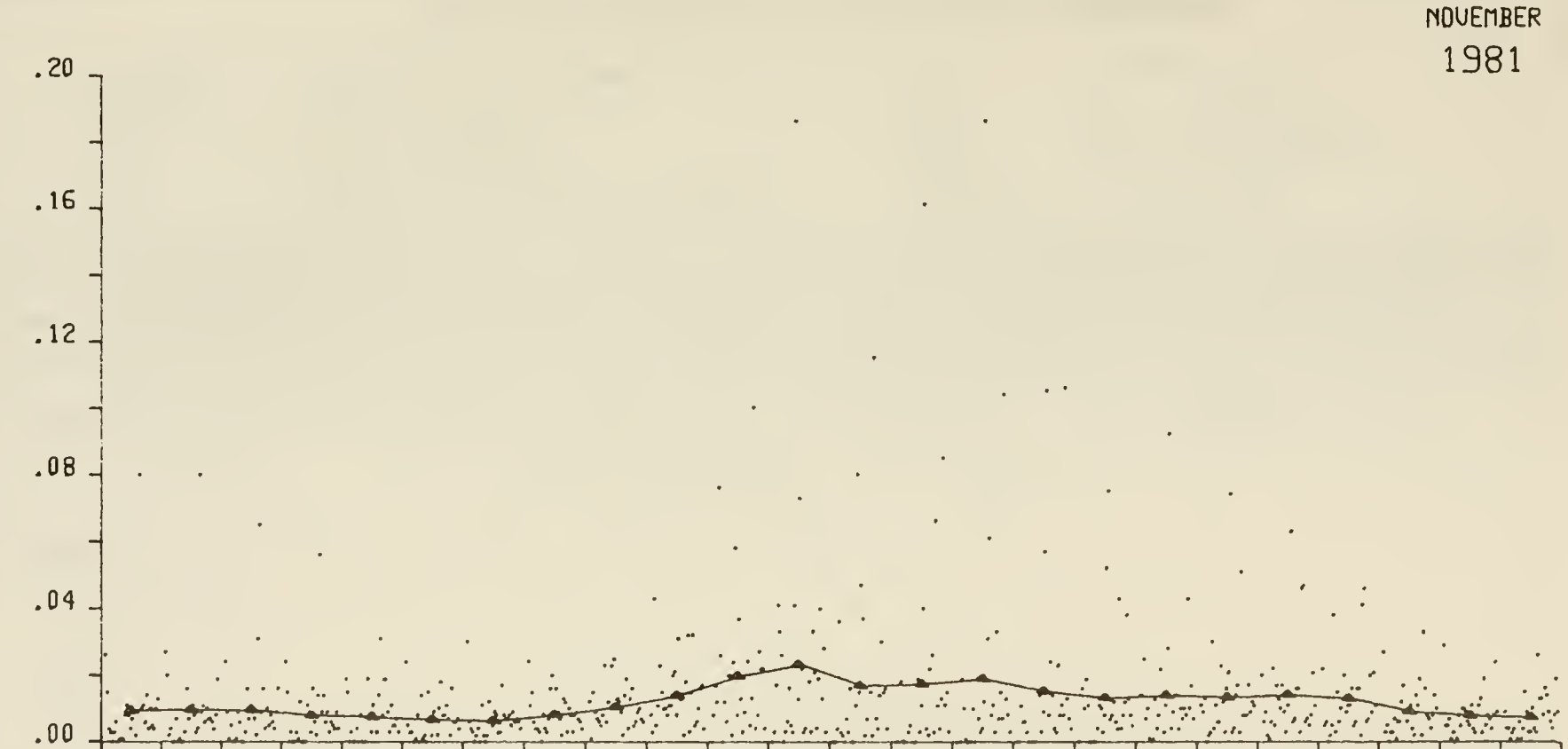
8. The AQB operated a sulfur dioxide SPM site at Shawnee Park for the first nine months of 1982. The site was located in a grassy area just west of a trailer court near the I-94 and I-90 interchange two miles northeast of Lockwood. The site is 1.8 miles east northeast of the Exxon refinery and the Montana Sulfur and Chemical Company and 5.7 miles northeast of the Billings area sulfur dioxide sources.

   Sulfur dioxide concentrations during 1982 at the Shawnee Park site met all Montana and federal ambient standards. However, the average concentration for the first nine months of 1982 was 0.018 ppm, which is relatively close to the Montana standard for annual average (0.020 ppm).

   With the conclusion of the Billings SO_2 study in September of 1982, the AQB was unable to continue to operate this site. With limited manpower and due to higher concentrations at other sites, the AQB decided to shut the Shawnee Park site down. The Bureau has no intention of reopening this site.

9. The AQB has operated an SO_2 monitor at the Taft School in Billings since September of 1980. The Taft School site is a NAMS site and lies at the east edge of an older residential area and within 0.8 miles of three sulfur dioxide sources. The Conoco Refinery is situated 0.2 miles to the northeast, the Montana Power Corette Plant is 0.8 miles to the east, and the Great Western Sugar refinery is 0.7 miles to the south southwest.

   Sulfur dioxide concentrations at the Taft School site were in compliance with all state and federal ambient air standards during 1982. Figures 54, 55, 56 and 57 display the diurnal sulfur dioxide concentrations at the Taft School site for November of 1981 and January, May and August of 1982. These plots indicate that sulfur dioxide concentrations are generally lower at this site than most of the other



	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23
NUM-OBS	30	30	30	30	30	30	30	30	30	30	29	29	29	30	29	29	29	30	30	30	30	30	30	30
1-HIGH	.080	.080	.065	.056	.031	.024	.030	.024	.025	.043	.100	.186	.115	.161	.186	.106	.075	.092	.074	.063	.046	.033	.029	.026
2-HIGH	.026	.027	.031	.024	.019	.018	.017	.020	.023	.032	.076	.073	.080	.085	.104	.105	.052	.043	.051	.047	.041	.027	.024	.019
HR.AVG	.009	.010	.010	.008	.008	.007	.006	.008	.011	.014	.020	.023	.017	.017	.019	.015	.013	.014	.014	.014	.013	.009	.008	.008

PLOT. . . . . CONCENTRATION VERSUS TIME (MON-SUN)
METHOD . . . . . PULSED FLUORESCENT
UNITS . . . . . PARTS PER MILLION
STANDARDS . . . (STATE) .50 PPM 1-HR AVG

PARAMETER . . SULFUR DIOXIDE
AREA. . . . . 0080, YELLOWSTONE CO
SITE. . . . . 062, TAFT SCHOOL
CITY. . . . . BILLINGS

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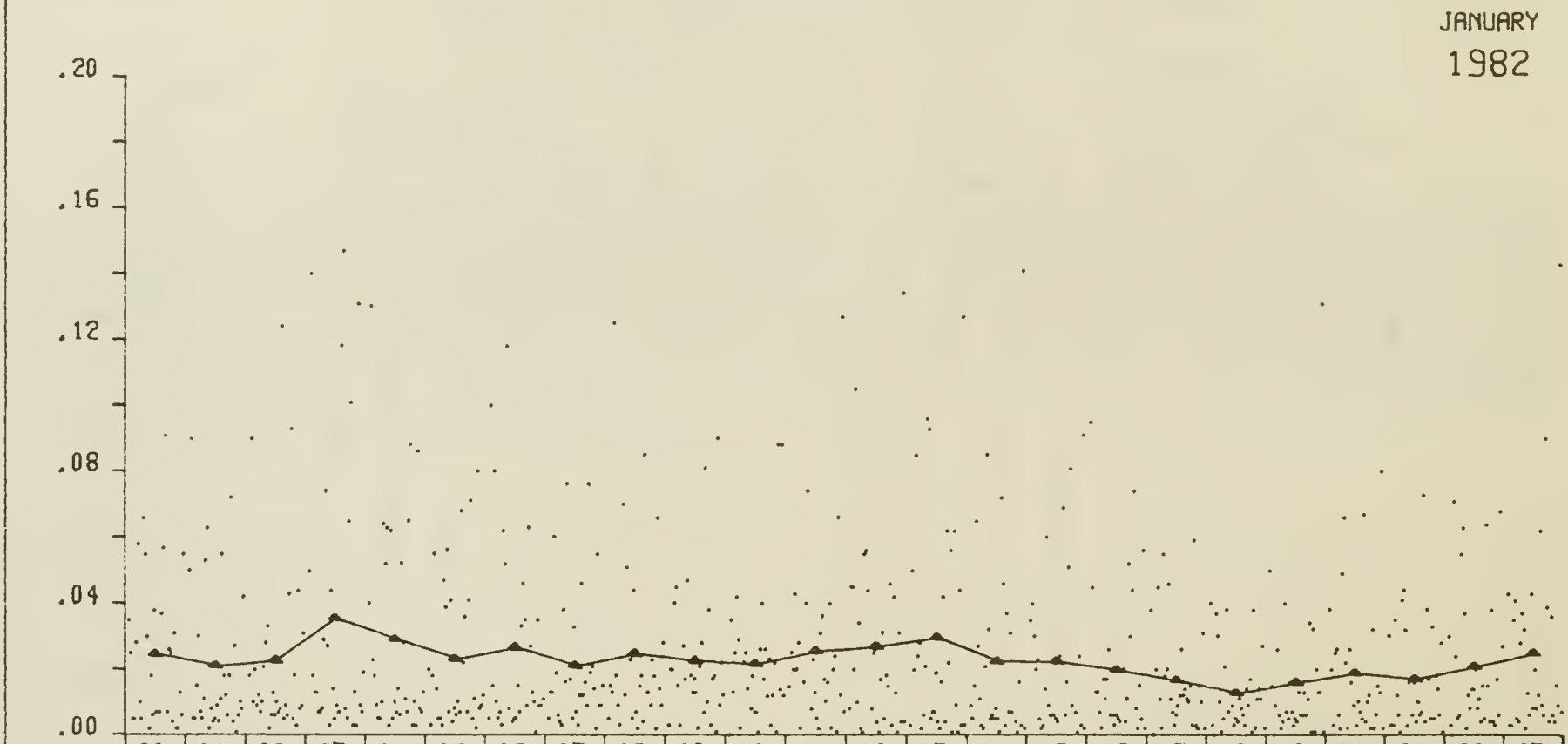
Figure 55



	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23
NUM-OBS	31	31	31	31	31	31	31	30	29	29	29	29	30	31	30	29	30	31	31	31	31	31	31	31
1-HIGH	.091	.090	.124	.147	.130	.080	.118	.076	.125	.090	.088	.127	.134	.127	.141	.091	.095	.059	.040	.131	.080	.073	.071	.143
2-HIGH	.066	.072	.093	.140	.088	.071	.100	.076	.085	.081	.088	.074	.105	.096	.085	.081	.074	.055	.038	.050	.067	.044	.068	.090
HR.AVG	.025	.021	.023	.036	.029	.023	.027	.021	.025	.023	.022	.026	.027	.030	.022	.022	.020	.017	.013	.016	.019	.017	.021	.025

PLOT. . . . . CONCENTRATION VERSUS TIME (MON-SUN)
METHOD . . . . . PULSED FLUORESCENT
UNITS . . . . . PARTS PER MILLION
STANDARDS . . . (STATE) .50 PPM 1-HR AVG

PARAMETER . . SULFUR DIOXIDE
AREA. . . . . 0080, YELLOWSTONE CO
SITE. . . . . 062, TAFT SCHOOL
CITY. . . . . BILLINGS

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Figure 56

	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23
NUM-OBS	25	25	25	25	25	25	24	23	23	23	22	22	22	23	24	24	24	24	24	24	24	24	24	24
1-HIGH	.043	.007	.004	.027	.045	.029	.025	.027	.154	.193	.156	.150	.155	.139	.089	.035	.043	.046	.059	.160	.017	.029	.011	.017
2-HIGH	.004	.003	.003	.019	.010	.012	.017	.018	.025	.035	.052	.057	.059	.016	.027	.024	.035	.015	.028	.031	.015	.015	.004	.008
HR.AVG	.002	.001	.001	.003	.004	.003	.004	.005	.012	.015	.016	.012	.014	.010	.008	.005	.007	.005	.005	.010	.003	.004	.002	.002

PLOT. . . . . CONCENTRATION VERSUS TIME (MON-SUN)
METHOD . . . . . PULSED FLUORESCENT
UNITS . . . . . PARTS PER MILLION
STANDARDS . . . (STATE) .50 PPM 1-HR AVG

PARAMETER . . SULFUR DIOXIDE
AREA. . . . . 0080, YELLOWSTONE CO
SITE. . . . . 062, TAFT SCHOOL
CITY. . . . . BILLINGS

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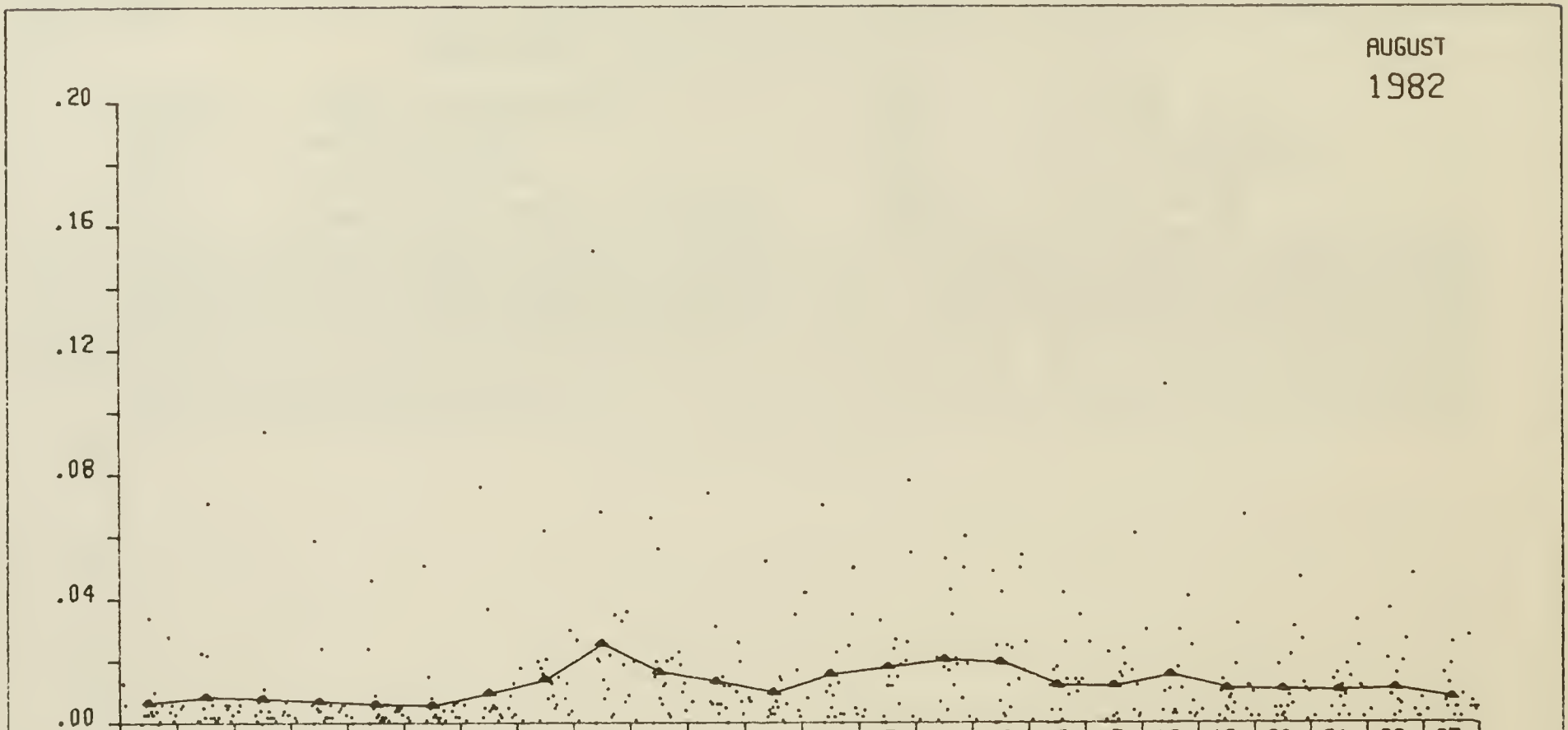
Figure 57



	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23
NUM-OBS	20	20	20	20	20	20	20	19	19	20	20	19	20	20	19	18	19	20	20	20	20	20	20	20
1-HIGH	.034	.071	.094	.059	.046	.051	.076	.062	.152	.066	.074	.052	.070	.078	.060	.054	.042	.061	.109	.067	.047	.033	.048	.028
2-HIGH	.028	.023	.011	.024	.024	.015	.037	.030	.068	.056	.031	.035	.050	.055	.053	.050	.035	.026	.041	.032	.031	.025	.037	.026
HR.AVG	.007	.009	.008	.007	.006	.006	.010	.014	.026	.017	.013	.010	.016	.018	.021	.020	.012	.012	.016	.011	.011	.011	.011	.008

PLOT. . . . . CONCENTRATION VERSUS TIME (MON-SUN)
METHOD . . . . . PULSED FLUORESCENT
UNITS . . . . . PARTS PER MILLION
STANDARDS . . . (STATE) .50 PPM 1-HR AVG

PARAMETER . . SULFUR DIOXIDE
AREA. . . . . 0080, YELLOWSTONE CO
SITE. . . . . 062, TAFT SCHOOL
CITY. . . . . BILLINGS

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sites. The AQB suspects that the emissions from the nearby sources are for the most part passing over the top of this monitoring site. The stack height of these sources vary from 120 feet for the Great Western Sugar refinery to 352 feet for the Montana Power Corette Plant.

The diurnal plots also show that the winter months have higher SO_2 concentrations than the summer. Peak concentrations occur during the morning hours between 8:00 a.m. and 11:00 a.m. with the exception of the January plot, where the maximum occurs at 3:00 a.m.

The AQB intends to shut down this site on January 1, 1984 due to the relatively low concentrations registered. The Lockwood Park site will become the new Billings NAMS site at that time.

10. The Metra-Fairgrounds SO_2 monitor operated from December 1981 to April 1982. The site is located in a narrow part of the Yellowstone Valley between Billings and Lockwood.

    Sulfur dioxide levels at this location are low, indicating that sulfur dioxide plumes from Billings and Lockwood do not necessarily follow the Yellowstone Valley.

    Due to low concentrations, the AQB terminated sulfur dioxide monitoring at this site during April of 1982 and does not intend to restart in the future.

11. GeoResearch, Inc. operated the Laurel BN site from September of 1981 through September of 1982. The site was part of the Billings SO_2 study and was located across the road and south of the Burlington Northern roundhouse. This area is approximately one mile northeast of the CENEX refinery. The location was selected as an area of maximum impact based on the results of a dispersion model performed by the AQB.

Sulfur dioxide concentrations proved to be relatively low at the BN site. Due to the low readings the site was permanently shut down at the conclusion of the Billings sulfur dioxide study. Since the New Farm site was shut down earlier, all SO_2 monitoring in Laurel ceased in September of 1982.

The Bureau intends to calibrate the dispersion model based on data from these two monitors and determine if any additional "hot spots" are predicted. If a so-called "hot spot" is identified, a new site will be located there. The AQB also intends to identify any hot spots by a review of the Yellowstone County sulfation plate data. Two possible locations are near the original Farm site and about four to eight miles northeast of the CENEX Refinery.

12. The AQB operated an SO_2 monitor at the New Farm site in Billings until June of 1982. The site was located in an agricultural area 1.5 miles east northeast of the CENEX refinery in Laurel. The site was located to monitor an area of maximum impact as predicted by a dispersion model performed by the AQB.

    Sulfur dioxide concentrations were relatively low at this location and the site was shut down in June of 1982. Any additional monitoring for SO_2 in the Laurel area will be based on the results of the dispersion modeling and sulfation rate data discussed in paragraph 11 above.

13. The AQB intends to convince the Yellowstone County Air Pollution Agency to enlarge its sulfation plate network or start a state network to investigate sulfur dioxide concentrations in the high terrain area two to seven miles southeast of Billings. Depending on the results from the network, continuous sulfur dioxide monitoring may be initiated in the area.

Sidney

1. Sidney is a city of approximately 5700 people situated in extreme eastern Montana. It is the site of several sulfur dioxide and hydrogen sulfide emission sources. These include the Montana Dakota Utilities coal-fired generating facility, the Shell Oil gas plant, the Perry Petrolane gas plant, and numerous oil well flares and vents. In recent months the AQB has recieved numerous questions concerning permit applications for possible new SO_2 and H_2S sources in this area.
2. The Bureau intends to install continuous SO_2 and H_2S monitors in the Sidney area if manpower is available. The Bureau is investigating the possibility of transferring a position from Helena to Sidney to accomplish this task. In the meantime, the AQB will continue to operate a sulfation plate network in the area.

Missoula

1. Over the past few years the Missoula County Health Department has been revising local rules and regulations to alleviate the total suspended particulate problem. During this process local citizens have expressed concern that the particulate problem could be compounded by synergistic effects from sulfur dioxide emissions from coal burning stoves. Although present coal use in Missoula is almost non-existent, some forecasts indicate substantial future use. In order to establish present sulfur dioxide levels, the Missoula County Health Department operated an SO_2 monitor at Rose Park during November and December of 1982 and January of 1983.
2. Sulfur dioxide concentrations were just barely detectable and therefore the site was shut down. Missoula County personnel have no future plans for sulfur dioxide monitoring at this time.

Great Falls

1. If manpower and equipment is available, the AQB with the cooperation of the Cascade County Health Department may establish a continuous sulfur dioxide site in the Black Eagle area. The primary purpose of the site would be to establish maximum ambient sulfur dioxide levels resulting from the Simmons Oil Refinery.

Colstrip

1. The AQB may establish a continuous sulfur dioxide monitor near Colstrip. With Units number 3 and 4 about to come on line, sulfur dioxide emissions are likely to increase. The site will only be established if manpower and equipment are available.

CARBON MONOXIDE (CO)

Automobile exhaust is the principal source of CO emissions, although some industries also emit CO, and agricultural or forestry burning are contributors in some areas. In some western Montana valleys, residential wood burning is an important source.

The AQB with the cooperation of the various county agencies is currently monitoring CO at two locations in Missoula and one each in Great Falls and Billings.

During 1981 and 1982 the AQB installed dilution systems at the Great Falls Federal, Billings Fairgrounds and Missoula Malfunction Junction sites to allow for multipoint calibrations. A similar system or additional CO cylinders will be installed at the Missoula Boyd Park site as soon as the necessary equipment is modified and/or purchased.

Billings

1. The Billings downtown area was designated non-attainment for carbon monoxide due to high readings in the past. These readings were taken at the 27th and Montana site but this site had to be removed due to building construction. A new site was established at the Billings Metra-Fairgrounds complex.
2. In 1982 an eight-hour high of 6.4 ppm was recorded (see Table 32). Figure 58 shows the diurnal pattern of carbon monoxide concentrations at the Fairground site for January of 1982. This plot displays the typical 8:00 a.m. and 5:00 p.m. CO peaks associated with traffic. The levels remain high throughout the late night period, which is probably attributable to traffic leaving the Metra after evening events.

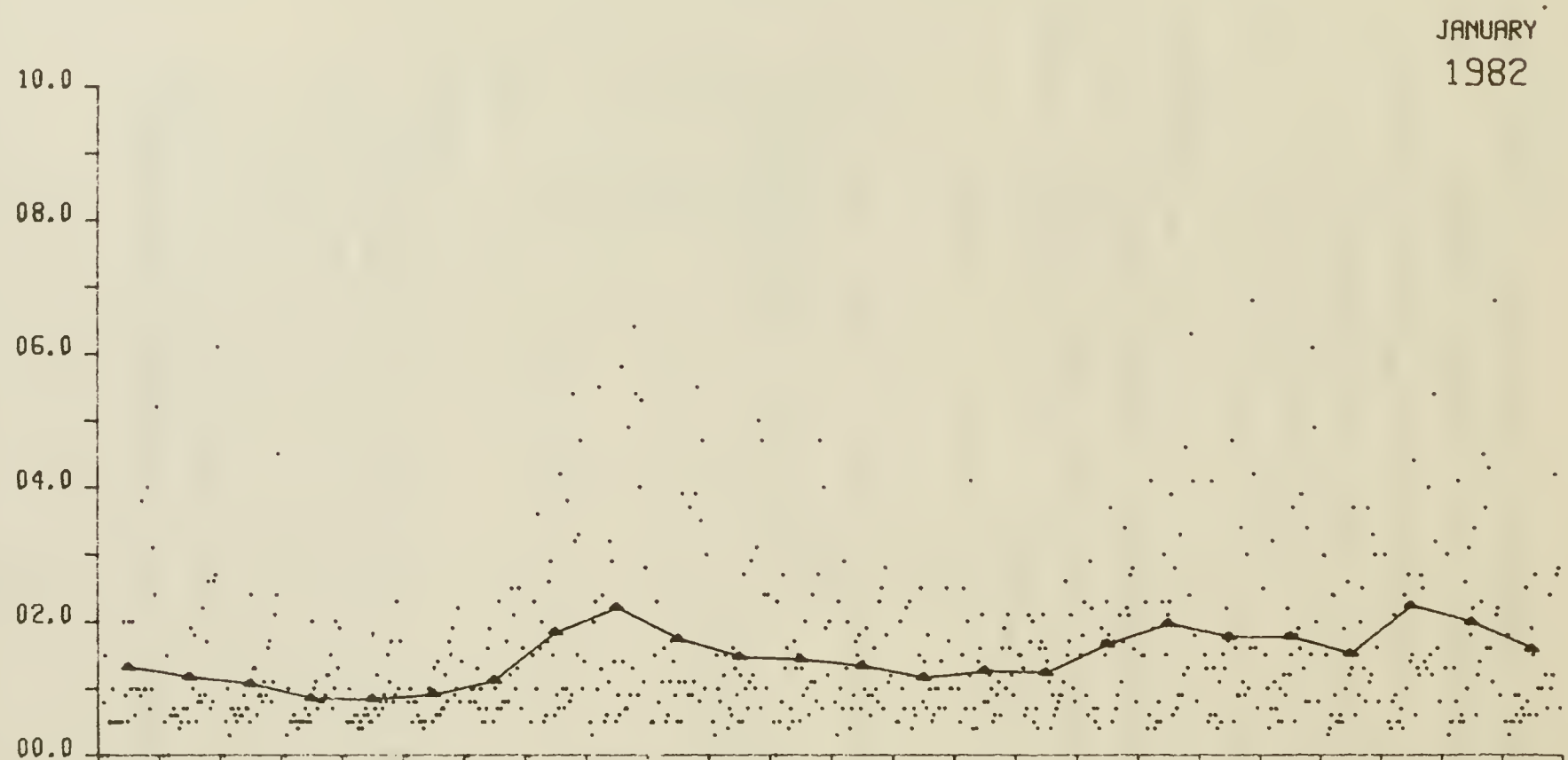
TABLE 32

MONTANA CARBON MONOXIDE DATA FOR 1982
(ppm)

City	Site	1-hour Max.	Max. 8-hour Mean
Missoula	Malfunction Junction	19.9	15.0
Missoula	Boyd Park	13.4	9.2
Billings	Fairground	17.5	6.4
Great Falls	Federal	9.7	5.4

3. The Fairgrounds site is located some distance from Exposition Drive due to siting problems. Therefore, the relatively low CO concentrations observed were expected. The Yellowstone County Air Pollution Control Agency plans to use data from this site to calibrate a model of emissions from Exposition Drive and to thereby provide control strategy tracking. The AQB recommends the continued operation of this site at

Figure 58



	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23
NUM-OBS	31	31	31	31	31	31	31	31	31	29	30	31	31	29	31	31	31	31	30	31	31	31	31	31
1-HIGH	5.20	6.10	4.50	2.00	2.30	2.20	2.50	5.40	6.40	5.50	5.00	4.70	2.90	2.50	4.10	2.60	3.70	6.30	6.80	6.10	3.70	17.5	6.80	11.2
2-HIGH	4.00	2.70	2.40	2.00	1.80	1.90	2.50	4.70	5.80	4.70	4.70	4.00	2.80	2.50	2.50	2.10	3.40	4.60	4.70	4.90	3.70	5.40	4.50	4.20
HR.AVG	1.31	1.18	1.07	.855	.852	.919	1.13	1.85	2.21	1.74	1.48	1.44	1.33	1.16	1.26	1.24	1.66	1.97	1.77	1.77	1.52	2.23	1.99	1.59

PLOT. . . . . CONCENTRATION VERSUS TIME (MON-SUN)
METHOD . . . . . NON-DISPERSIVE INFARED
UNITS . . . . . PARTS PER MILLION
STANDARDS . . . (FEDERAL) 9 PPM 8-HR / 35 PPM 1-HR

PARAMETER . . CARBON MONOXIDE
AREA. . . . . 0080, YELLOWSTONE CO
SITE. . . . . 061, FAIRGROUNDS (METRA)
CITY. . . . . BILLINGS

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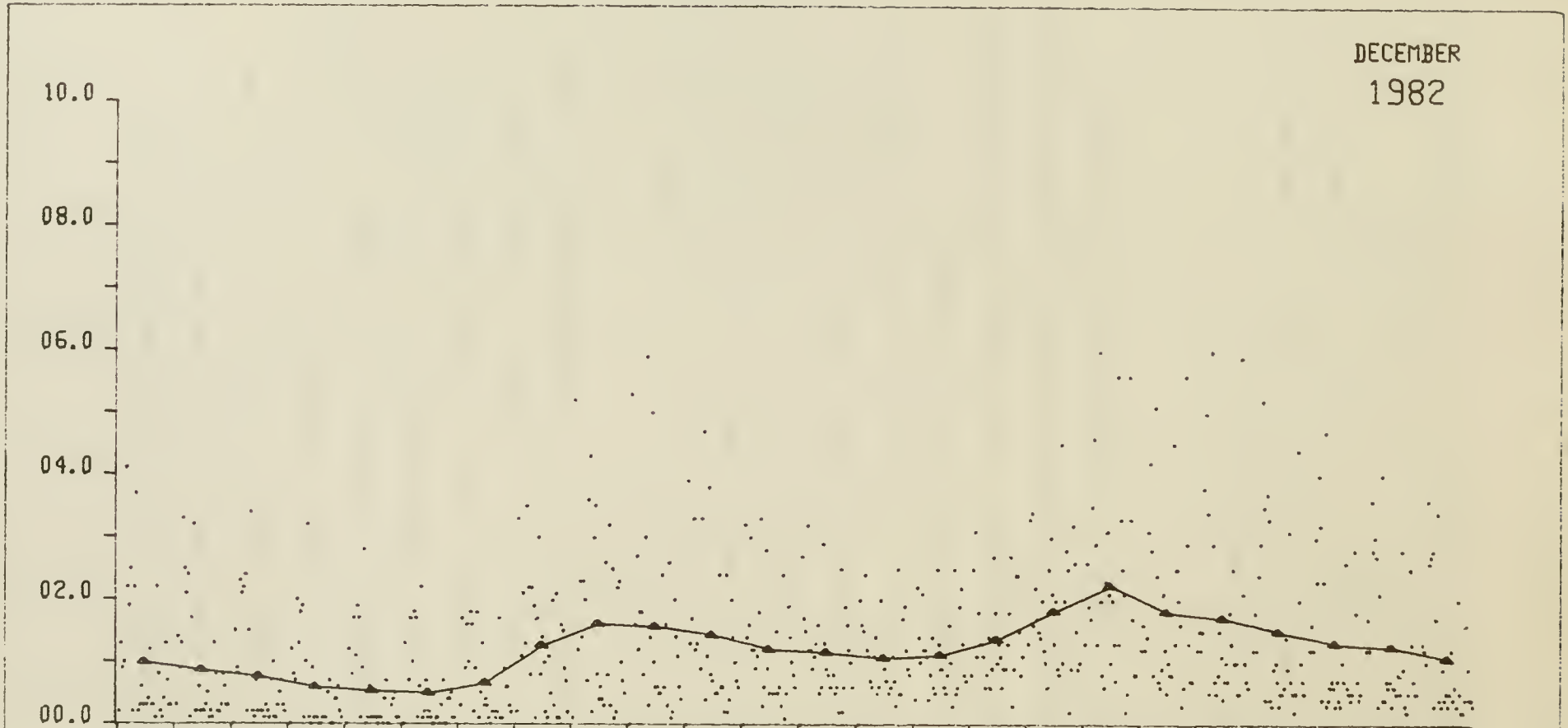
least until the improvements to Exposition Drive have been completed. Currently the site is only operated during the winter months (October-March), since the highest concentrations of carbon monoxide occur then and since the CO standard is a short-term standard. If manpower becomes available, the site will be operated year around.

Great Falls

1. In 1979 CO sampling was conducted at 10th Avenue South and 9th Street. This site was used to designate the area non-attainment. Due to a leasing problem, the site had to be relocated a short distance away on 10th Avenue South at the Great Falls Federal Savings and Loan Building.
2. During 1982, CO levels at the Great Falls Federal site were in compliance with all state and federal ambient air quality standards (see Table 32). Figure 59 shows the diurnal distribution of carbon monoxide concentrations at the Great Falls Federal site during December of 1982. The plot shows the expected peaks at 8:00 a.m. and 5:00 p.m. indicating that tailpipe emissions are the major source of CO in Great Falls.
3. In the past the AQB assumed that traffic on 10th Avenue South was responsible for carbon monoxide violations at the Great Falls Federal site. However, in 1982 the AQB performed an analysis of carbon monoxide concentrations versus wind speed and direction and uncovered some startling results. Unexpectedly the highest CO concentrations occurred with northeast winds. This wind direction would carry CO emissions from 10th Avenue South away from the monitor. Further examination showed that quite often the higher concentrations were associated with a shallow mass of cold air drifting in from the northeast. In fact during some episodes wind at

Figure 59



	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23
NUM-OBS	31	31	31	31	30	30	30	30	30	30	29	31	31	31	31	31	31	31	31	31	31	31	31	31
1-HIGH	4.10	3.30	3.40	3.20	2.80	2.20	1.80	3.50	5.20	5.90	4.70	3.30	3.20	2.50	2.50	3.10	4.50	6.00	5.60	6.00	5.20	4.70	4.00	3.60
2-HIGH	3.70	3.20	2.40	2.00	1.90	1.80	1.80	3.30	4.30	5.30	3.90	3.20	2.90	2.40	2.50	2.70	3.40	5.60	5.10	5.90	4.40	4.00	3.60	3.40
HR.AVG	.994	.865	.765	.597	.533	.507	.667	1.26	1.62	1.57	1.44	1.21	1.17	1.07	1.13	1.38	1.83	2.23	1.81	1.71	1.50	1.31	1.25	1.07

PLOT. . . . . CONCENTRATION VERSUS TIME (MON-SUN)
METHOD . . . . . NON-DISPERSIVE INFARED
UNITS . . . . . PARTS PER MILLION
STANDARDS . . . (FEDERAL) 9 PPM 8-HR / 35 PPM 1-HR

PARAMETER . . CARBON MONOXIDE
AREA. . . . . 0660, CASCADE CO
SITE. . . . . 021, GREAT FALLS FEDERAL
CITY. . . . . GREAT FALLS

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Malmstrom Air Force Base and presumably in Great Falls were northeast while winds at the Great Falls Airport were still southwest. However, winds at the airport usually shifted northeast during the later stages of the episodes. Since these cold air masses are shallow and moving in from the northeast, wind at the air base (one mile east of Great Falls and at a similar elevation) would shift to the northeast first, followed by Great Falls and finally the airport, which is one mile southwest of the city and 300 feet higher. In light of this information, the AQB now suspects that the high CO concentrations are caused by citywide emissions which are being trapped in the shallow mass of cold air.

4. The Great Falls City-County Planning Board hired PEDCo ENVIRONMENTAL, INC. to evaluate the magnitude and geographical distribution of Great Falls CO levels and to make recommendations as to possible solutions. PEDCo ENVIRONMENTAL INC. operated a CO analyzer on Central Avenue in the downtown area during December of 1981 and January and February of 1982. During the sampling period one exceedance of the 8-hour standard was recorded. An 8-hour average of 15.5 ppm occurred on December 9, 1981. Since there was only one exceedance of the standard, the central business district of Great Falls remains attainment for CO. However, the higher than expected concentrations seems to substantiate the proposed theory in paragraph 3.

5. PEDCo also performed a dispersion model of the CO emissions in the vicinity of 10th Avenue South. The results of the model indicate that the attainment status is questionable at several intersections along 10th Avenue South. PEDCo ENVIRONMENTAL, INC. points out that the average speed of vehicles on 10th Avenue South is critical. A five mile per hour

increase may result in compliance. The AQB originally believed that the completion of the additional lanes on the 10th Avenue South bridge and a traffic light synchronization project would sufficiently increase the average vehicle speed and solve the problem. In light of paragraph 3 above, the AQB is now considering new citywide control strategies.

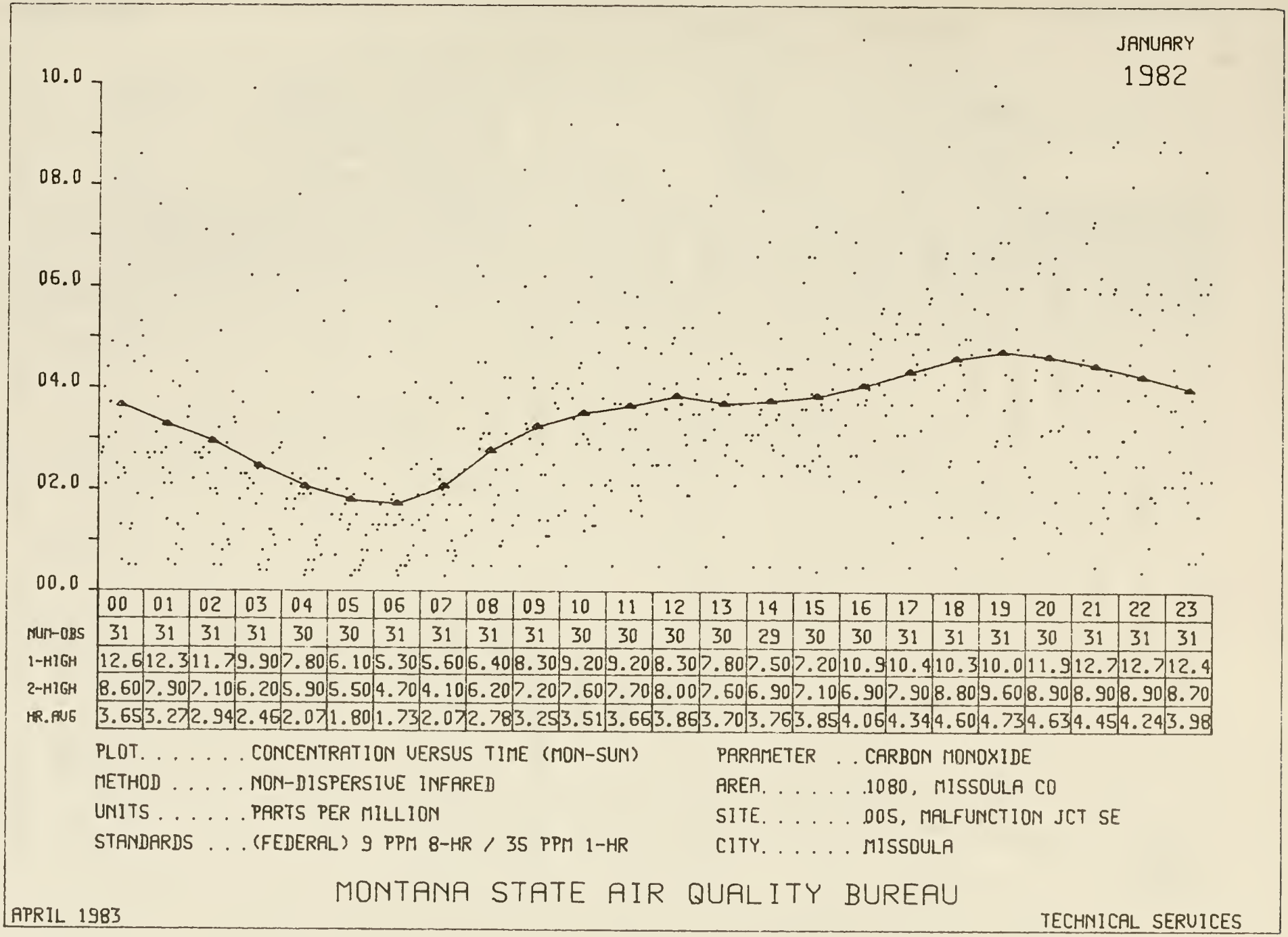
6. The AQB recommends that the Great Falls Federal site continue to be operated and/or a new site be initiated along 10th Avenue South but closer to the Missouri River. The PEDCo model indicated higher concentrations nearer the river and the AQB suspects that the shallow cold air masses may cause higher concentrations to occur in the lowest part of the valley.

Missoula

1. Part of Missoula was designated non-attainment for CO based on high concentrations recorded at the Malfunction Junction site. This site is located near the congested intersection of South Avenue, Russell Street, and U.S. 93. Violations of the 8-hour CO standard have also been observed at Lions Park, along Higgins Avenue in the downtown area and at Boyd Park.
2. Figures 60 and 61 show diurnal CO concentrations at two Missoula locations. In the 1981 Network Review the AQB suggested that inversion conditions during the winter have a greater effect on hourly CO concentrations than traffic volume and wood burning emissions. The 1982 data seems to substantiate this hypothesis.

During November and December, Missoula is almost always experiencing poor ventilation. The ability of the airshed to disperse pollutants is limited to a relatively slow constant rate with some improvement during the middle of the day. The AQB speculates that during the day the emission rate from automobiles and wood burning are almost equal to the rate of dispersal with

Figure 60



	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23
NUM-OBS	31	31	31	31	30	30	31	31	31	31	30	30	30	30	29	30	30	31	31	31	30	31	31	31
1-HIGH	12.6	12.3	11.7	9.90	7.80	6.10	5.30	5.60	6.40	8.30	9.20	9.20	8.30	7.80	7.50	7.20	10.9	10.4	10.3	10.0	11.9	12.7	12.7	12.4
2-HIGH	8.60	7.90	7.10	6.20	5.90	5.50	4.70	4.10	6.20	7.20	7.60	7.70	8.00	7.60	6.90	7.10	6.90	7.90	8.80	9.60	8.90	8.90	8.90	8.70
HR.AVG	3.65	3.27	2.94	2.46	2.07	1.80	1.73	2.07	2.78	3.25	3.51	3.66	3.86	3.70	3.76	3.85	4.06	4.34	4.60	4.73	4.63	4.45	4.24	3.98

PLOT. . . . . CONCENTRATION VERSUS TIME (MON-SUN)
METHOD . . . . . NON-DISPERSIVE INFARED
UNITS . . . . . PARTS PER MILLION
STANDARDS . . . (FEDERAL) 9 PPM 8-HR / 35 PPM 1-HR

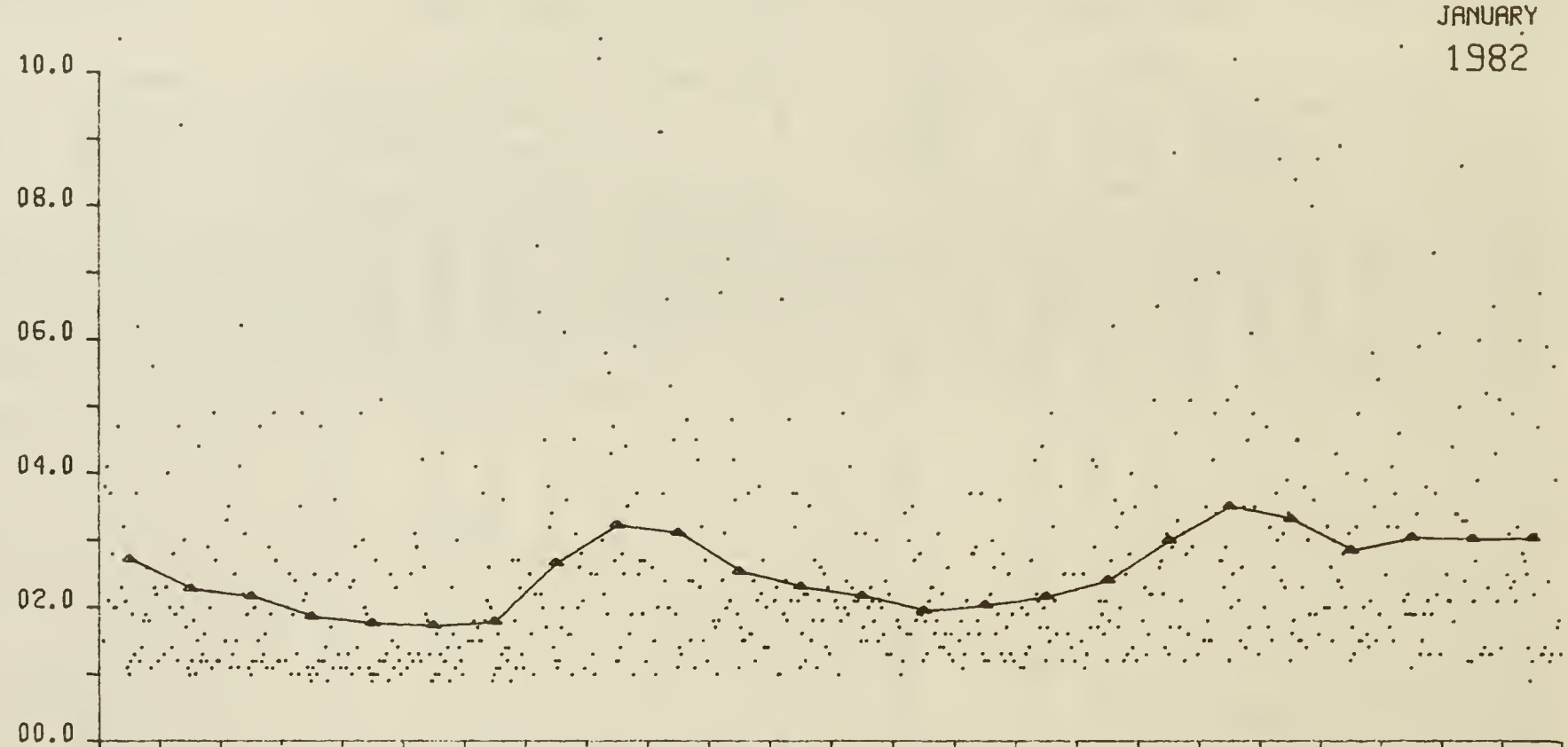
PARAMETER . . CARBON MONOXIDE
AREA. . . . . 1080, MISSOULA CO
SITE. . . . . 005, MALFUNCTION JCT SE
CITY. . . . . MISSOULA

MONTANA STATE AIR QUALITY BUREAU

APRIL 1983

TECHNICAL SERVICES

Figure 61



	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23
NUM-OBS	31	31	31	31	31	31	31	31	31	29	30	31	30	31	30	27	30	30	31	31	31	31	31	31
1-HIGH	10.5	9.20	6.20	4.90	5.10	4.30	4.10	7.40	10.5	9.10	7.20	6.60	4.90	3.50	3.70	4.90	6.20	8.80	10.2	8.70	8.90	10.4	8.60	10.6
2-HIGH	6.20	4.90	4.90	4.70	4.90	4.20	3.70	6.40	10.2	9.10	6.70	4.80	4.10	3.40	3.70	4.40	4.20	6.90	9.60	8.70	5.80	7.30	6.50	6.70
HR.AVG	2.71	2.28	2.16	1.86	1.77	1.73	1.80	2.66	3.23	3.11	2.54	2.31	2.17	1.95	2.04	2.16	2.41	3.00	3.51	3.31	2.85	3.05	3.03	3.04

PLOT. . . . . CONCENTRATION VERSUS TIME (MON-SUN)
METHOD . . . . . NON-DISPERSIVE INFARED
UNITS . . . . . PARTS PER MILLION
STANDARDS . . . (FEDERAL) 9 PPM 8-HR / 35 PPM 1-HR

PARAMETER . . CARBON MONOXIDE
AREA. . . . . 1100, MISSOULA CO
SITE. . . . . 024, BOYD PARK
CITY. . . . . MISSOULA

MONTANA STATE AIR QUALITY BUREAU

APRIL 1983 TECHNICAL SERVICES

the exception of the 8 a.m. traffic peak. However, after about 3 p.m. the emission rate definitely exceeds the dispersion rate and CO levels start to climb. After midnight when emissions are dropping rapidly, the rate of dispersal again exceeds the emissions and concentrations begin to decline.

3. Table 32 summarizes the carbon monoxide data for 1982 at the Missoula monitoring sites. The Malfunction Junction S.E. site continued to register eight-hour concentrations over the state and federal standards. The highest eight-hour average concentration was 15.0 ppm and was recorded during December. The Boyd Park site also exhibited an eight-hour average over the 9 ppm standard. An eight-hour average of 9.2 ppm was recorded during January.

4. The Missoula County Health Department temporarily shut down the Malfunction Junction carbon monoxide site in July of 1983. The County plans to reactivate the site after the reconstruction of the intersection is complete. However, possible construction at the Fairground may require a minor site relocation. The AQB and Missoula County consider the long-range operation of this site as essential for several reasons, including: (1) the very high concentrations observed there; (2) the site's significance in regard to non-attainment designation and tracking; and (3) the large amount of historical data.

5. The Missoula County Health Department operates a carbon monoxide monitor at Boyd Park in the southern part of the city. The site is located in a residential area which is almost entirely free of traffic influence. However, this part of the city has a very high use of wood for residential heating and recreation. The AQB and Missoula County are convinced that wood burning is the major cause of high CO concentrations at this site. However, this conclusion is somewhat undermined by the fact that typical 8:00 a.m. and 5:00 p.m. traffic peaks appear on the Boyd Park diurnal plot (Figure 61).

The Department recommends that this site continue to be operated if a dilution system or additional CO cylinders can be obtained and installed by September of 1983. To save money, Missoula County intends to run the site only during the winter. They suggest that high readings are non existent in the summer and that the CO standard is a short-term standard. If manpower becomes available, year around monitoring will be resumed.

Libby

Libby is a small town in northwestern Montana which has very poor atmospheric dispersion and an extremely high usage of wood for home heating.

In light of Libby's extremely high total suspended particulate levels and the high CO concentrations observed in residential areas of Missoula, the AQB recommends that carbon monoxide monitoring be initiated in Libby. The location of the site was discussed earlier in conjunction with the section on total suspended particulates.

General Comments

Table 33 lists the traffic counts for the major intersections throughout Montana. Each of these areas is a potential site for future carbon monoxide monitoring. Despite this list the AQB has prioritized Libby as the number one candidate for future CO monitoring. The results of CO monitoring in Libby will determine whether the AQB will concentrate on monitoring in areas of heavy residential wood burning or near major traffic routes.

TABLE 33

TRAFFIC COUNTS FOR MAJOR MONTANA INTERSECTIONS
Average Daily Traffic

Billings	
Main Street just south of Wicks Lane	25,000*
Main Street just north of State 318	30,400
Main Street just north of 7th Ave. No.	27,583
Exposition Drive just south of 6th Ave. No.	29,500*
Exposition Drive between 2nd and 3rd Ave. No.	17,000*
1st Ave. No. just west of Exposition Dr.	19,000*
Grand Avenue between 1st St. W - Division Street	22,656
State Avenue just west of Orchard Lane	23,640
Grand Avenue between 5th & 6th St. West	23,000*
Grand Avenue just east of 17th St. West	20,000*
Grand Avenue just east of 15th St. West	22,000*
Main Street just south of Milton Road	26,000
24th Street West between Wyoming Ave. & Broadwater	20,000*
Bozeman	
7th & Main	20,500*
Butte	
Amherst & Harrison	19,000*
Front & Utah	18,150
Great Falls	
Central Ave. and Bypass	20,890
10th Ave. So. and 9th Street	30,000*
Helena	
Lyndale, Montana Avenue and Helena Avenue	19,100
Kalispell	
Main Street and Idaho	19,000*
Missoula	
Brooks, South, & Russell (Malfunction Junction)	20,350
Russell and Broadway	21,280
Downtown	18,500*

*estimated

FLUORIDES (F^-)

During 1981 the Montana Board of Health and Environmental Sciences adopted new ambient standards for fluorides. The standards are based on the concentration of fluoride in forage. The standards were set at 50 ppm for a monthly average and 35 ppm for a grazing season average.

The AQB is auditing vegetation sampling conducted by the Stauffer Chemical Company and the Anaconda Aluminum Plant to determine compliance. In addition the AQB receives sample splits from both companies and analyzes them in the Department's laboratory.

In an attempt to better define "grazing season," the Stauffer Chemical Company in cooperation with the AQB has selected an additional sampling plot to gather a sample for a digestible energy analysis. The results of this analysis will assist in determining whether the livestock is obtaining its minimum nutritional needs.

SULFATION RATE

In addition to continuous SO_2 monitors, the AQB will continue to use sulfation plates as indicators of sulfur emissions. The AQB and Yellowstone County will continue to use sulfation plates in Billings and Sidney. The uses of sulfation plates around new oil well flares and gas sweetening plants is often required by the AQB as a permit condition. The AQB also intends to run sulfation plates at some continuous monitoring sites to develop a relationship between sulfation rate and sulfur dioxide concentrations.

OZONE (O_3)

Ozone in the lower atmosphere generally is formed by reactions of various photochemical substances with hydrocarbons and nitrogen oxides produced by automobiles and some industrial sources, such as refineries. Natural sources of

ozone include formation by lightning and transport of stratospheric ozone to lower levels, but concentrations due to these causes typically are very low. Ozone due to man's activities is a secondary pollutant that requires an accumulation of precursor emissions (hydrocarbons and/or nitrogen oxides), warm, sunny weather, and relatively little ozone removal, for high concentrations to develop. Because several hours are required for ozone formation, and because large accumulations or precursor emissions are most likely in air that travels across a precursor emitting region, maximum concentrations of ozone generally are found five to seven hours after rush hour downwind of the emitting region. Warm temperatures facilitate ozone formation, so high concentrations generally are confined to the warmer months.

During the fall of 1981 the Bureau terminated ozone monitoring at the Shawnee Park site near Billings. With the start of the Billings SO_2 study, the Bureau's Billings operator had insufficient time to operate this site. If manpower becomes available, the Bureau may reactivate ozone monitoring downwind of Billings.

In the 1981 Network Review the AQB recommended a future ozone site located east northeast of Great Falls. Since then the Bureau has received data from the Montana Power Company monitoring site 15 miles east northeast of Great Falls. The AQB will continue to review data from this site and therefore sees no need for a state site in the same area.

Modifications to the Ozone Network

1. By 1985, the Bureau plans to reestablish an SPM monitor between 10 and 40 miles east-northeast of Billings.

NITROGEN DIOXIDE (NO_2)

Nitrogen dioxide is a toxic, corrosive, and highly oxidizing gas formed from oxidation of nitric oxide (NO), a process that typically requires about two hours reaction time. Since the automobile is the primary source of NO, highest concentrations of nitrogen dioxide generally occur downwind of rush hour traffic areas.

With the completion of the Montana Air Pollution Study, the Bureau terminated all nitrogen dioxide sampling throughout the state with the exception of Billings. A new site was established at the Fairgrounds in Billings; however, the analyzer was shut down due to lack of manpower and will remain shut down until sufficient manpower is available. At that time it may be reestablished at the same location as the proposed ozone monitor.

ACID PRECIPITATION

The State of Montana is generally removed from significant sources of sulfur dioxide and nitrogen oxides which are precursors of acid precipitation. Large concentrations of SO_2 and NO emitters generally lie at least 1000 miles east of Montana or in California and to a much smaller degree in the southwest. Wind patterns are such that Montana is almost never influenced by emissions from areas east of our state. However, emissions from the southwest and California on occasion can reach Montana.

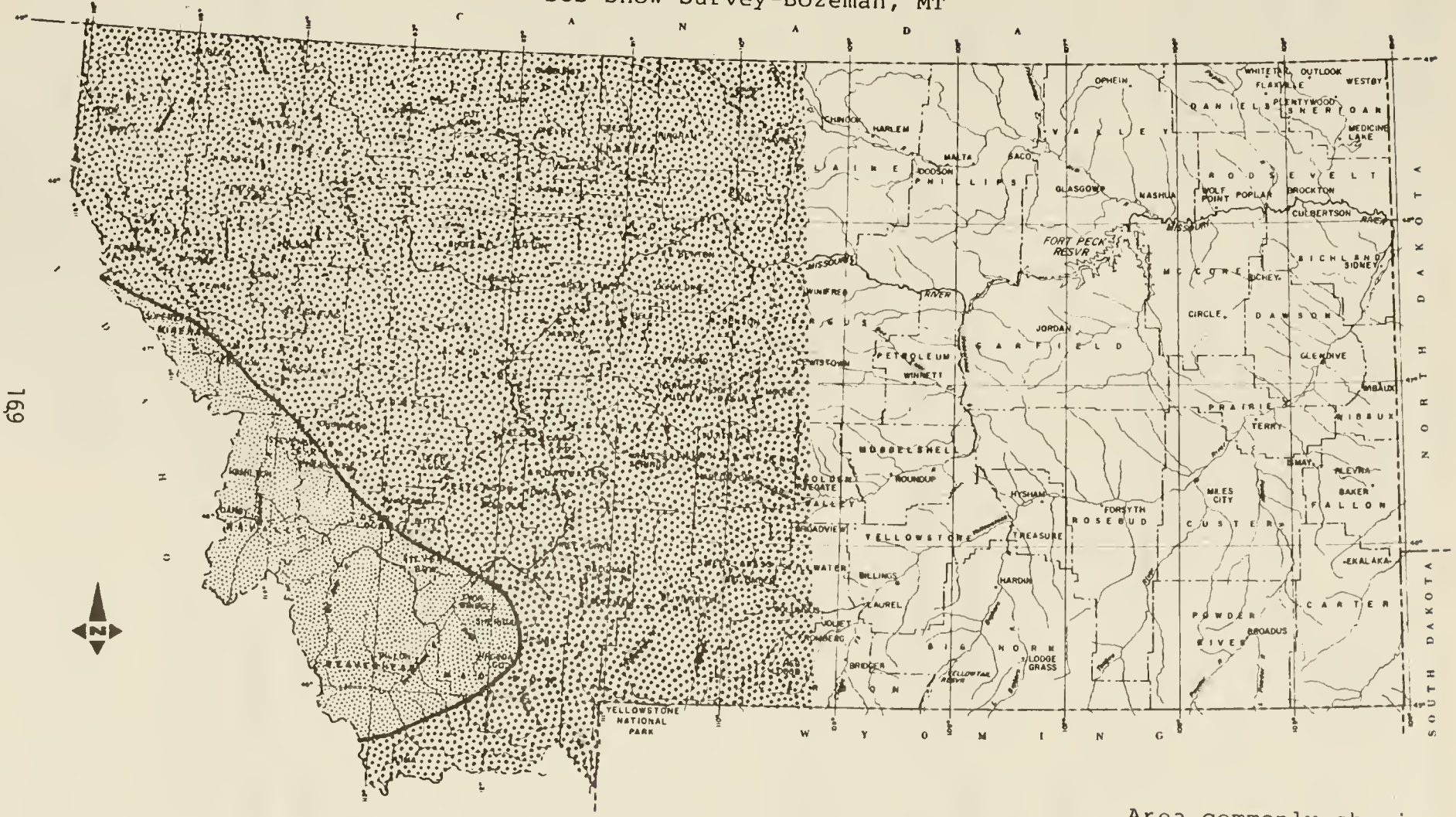
Dr. Gordon Pagenkopf of Montana State University has conducted snow surveys throughout western Montana for the past three years (Figure 62). The results of these studies have shown that Montana is receiving only minimal impacts from acid precipitation and that the impact is confined to extreme southwestern Montana along the Montana-Idaho border from Superior to Dillon.

Figure 62

Snowfall pH Study

Winter 1980-81

SCS Snow Survey-Bozeman, MT



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Area commonly showing pH of snowfall between 4.0 and 5.0

Area commonly showing pH of snowfall between 5.0 and 6.0

The AQB intends to pursue the goal of obtaining an acid precipitation monitor and installing it in southwestern Montana. Figure 62 shows some possible locations. In light of Dr. Pagenkopf's findings and because numerous power generating plants, coal liquifaction and gasification plants are proposed for the southwestern United States, the AQB considers this to be the optimum location. In addition, acid precipitation is already being monitored in Glacier National park by the National Park Service.

VISIBILITY

Libby

The AQB intends to operate a nephelometer in the Libby area during the fall months as part of the smoke management program. The site will be located north of Libby across the Kootenai River. This location will hopefully minimize the smoke impact from residential woodburning while effectively monitoring wood smoke originating from forestry slash burning.

The operator will visit the site each morning at 8:00 a.m. from September 1 to approximately November 30 and calculate the average scattering coefficient for the prior day, the past eight hours, and the past hour. This information will be passed along to the decision making monitoring unit in Missoula.

At the end of the season the data will be compared to the TSP readings in Libby as well as the various levels of slash burning restrictions that were issued for each day throughout the fall.

Scobey

Until July of 1983 the AQB operated a nephelometer at the Border site north of Scobey. The sampler was shut down with the rest of the Scobey network but will be reactivated when the final monitoring year commences.

Class I Area

If manpower and equipment are available, the AQB may establish a nephelometer site in a Class I area such as Glacier or Yellowstone National Parks. The Montana visibility standard only applies to Class I areas.

PRIORITIZATION OF PROPOSED NETWORK MODIFICATIONS

Table 34 presents a prioritized list of proposed modifications to the Montana ambient air monitoring network. The Bureau prioritized this list based on the importance of the changes and the financial costs involved. It is the Bureau's policy to operate the existing network correctly before initiating new projects; therefore, many quality assurance items are prioritized quite high.

The AQB will initiate the proposed modifications starting with item number one and proceeding to item 37 as manpower and money are available. However, the first group of modifications will be completed before each subsequent group is started.

TABLE 34

LIST OF PROPOSED MODIFICATIONS TO THE MONTANA AMBIENT MONITORING NETWORK

1. Establish a nephelometer site north of Libby to provide data for the smoke management program.

2. Modify the Missoula Courthouse Roof TSP site to provide for proper spacing between the samplers.

3. Establish a carbon monoxide, TSP and fine particulate site with chemical mass balance capabilities at Libby.

4. Upgrade the Missoula Boyd Park carbon monoxide calibration system to provide for multipoint calibrations.

5. Establish a TSP monitor in Dillon.

6. Either enlarge the Yellowstone County network of sulfation plates or start a state network to include the higher terrain two to seven miles southeast of Billings.

7. Establish a sulfur dioxide and hydrogen sulfide continuous monitoring site in the Sidney area.

8. Terminate sulfur dioxide monitoring at the Billings Taft School site and designate the Lockwood Park site a NAMS site.

9. Shut down or move the Missoula Rose Park meteorological system to Boyd Park.

10. Establish a new continuous sulfur dioxide site in the Laurel area.

11. Increase the frequency of colocated sampling at the Missoula Rose Park and Courthouse Roof sites to a one-in-three day cycle.

12. Terminate carbon monoxide monitoring at the Great Falls Federal site.

13. Terminate TSP monitoring in Lolo.

14. Establish a TSP monitor in East Missoula.

15. Terminate TSP monitoring at the Missoula Northside site.

16. Establish a TSP site with chemical mass balance capabilities near the ASARCo tailings pond near Troy.

17. Establish a TSP monitor in Eureka.

18. Return to year around operation of the North Johnson Lane sulfur dioxide site.

19. Establish a new carbon monoxide site in Great Falls closer to the Missouri River along Tenth Avenue South.

20. Establish a TSP monitor in the lower Rattlesnake area of Missoula.

21. Establish a TSP monitor in Superior.

22. Establish a TSP monitor in Deer Lodge.

23. Establish an acid precipitation site in southwestern Montana.

24. Based on the results of item six above, establish a continuous sulfur dioxide site in the higher terrain two to seven miles southeast of Billings.

25. Establish a TSP monitor at the Meadow Hills School in Missoula.

26. Establish a TSP monitor in the Target Range area of Missoula.

27. Establish a solar power high volume sampler (EPA equipment) somewhere in Montana on a trial basis for later use in remote or Class I areas.

28. Redesignate the Great Falls Downtown site as a SLAMS site and the Great Falls Fire Station as a NAMS site.

29. Run the Missoula Boyd Park and Billings Fairground carbon monoxide sites year around.

30. Initiate daily TSP sampling at Boyd Park in Missoula.

31. Establish TSP sampling in Patti Canyon near Missoula.

32. Establish an ozone site east of Billings.

33. Perform visibility monitoring in a Class I area - Glacier National Park or Yellowstone National Park.

34. Establish a nitrogen dioxide site east of Billings.

35. Establish a continuous sulfur dioxide site near Colstrip

36. Relocate the Great Falls Franklin School TSP site in February of 1984 if concentrations for the initial year are high; if not, shut the site down.

37. Establish a continuous sulfur dioxide site in the Black Eagle area of Great Falls.

RATIONALE FOR SITE DESIGNATIONS

The Bureau's stations are designated either NAMS, SLAMS or SPM, depending on the general purpose of the station and the period of time it is expected to operate.

In general, NAMS and SLAMS are intended to operate for long periods of time. Stations established for short-term measurements are normally designated SPM. If it later is decided to maintain the station beyond its originally projected closing date, the station could be redesignated SLAMS.

Table 35 explains the differences between NAMS, SLAMS and SPM sites, while Table 36 describes the various monitoring methods employed by the AQB. Table 37 explains the siting criteria associated with sampling each criteria pollutant.

TABLE 35

MAJOR STATION DESCRIPTIONS AND COMPARISONS

Monitoring Station	SLAMS	NAMS	SPM
Purpose	General program monitoring for criteria pollutants. Supplies data for state implementation plan (SIP). Used for emergency episode monitoring.	Sets national policy, obtains long-term trend data, is used in special national studies, and is selected to monitor highest pollution areas which also have high population.	Special and short-term monitoring according to Montana needs. Monitors non-criteria pollutants.
Review Frequency	Annual	Every third year	Annual
Relocation Frequency	Relocated or changed only on annual basis if necessary and with EPA approval.	Not to be moved	No restrictions
Data Reporting	Beginning in 1981, annual reports due by July 1st of the following year to EPA Region and headquarters in N. Carolina.	Same	No reports due unless data is used for SIP purposes.
Report Requirements	Detailed summary, including violations of standards.	Same	None

TABLE 36

SAMPLING AND ANALYSIS METHODS

Parameter	Method
TSP - all sites	High Volume Method 40 CFR, Part 50, Appendix B
Pb - all sites	High Volume Method 40 CFR, Part 50, Appendix B
SO_2 - all sites	EQSA-0276-009 "Thermo Electron Model 43 Pulsed Fluorescent SO_2 Analyzer"
CO - all sites	RFCA-0276-008 "Bendix Model 8501-5CA Infrared CO Analyzer"
	RFCA-0381-051 "Dasibi Model 3003 Gas Filter Correlation CC Analyzer"
O_3 - all sites	EQOA-0577-019 "Dasibi Model 1003-AH, 1003-PC, or 1003-RS Ozone Analyzers"
NO_2 - all site	RFNA-0677-021 "Monitor Labs Model 8440E Nitrogen Oxides Analyzer"

TABLE 37

SUMMARY OF PROBE SITING CRITERIA

Pollutant	Scale	Height above Ground, meters	Distance from Supporting Structure, meters Vert.	Horiz.	Other Spacing Criteria
TSP	All	2-15	--	2	1. Should be >20 meters from trees 2. Distance from sampler to obstacle must be at least twice the height the obstacle protrudes above the sampler. 3. Must have unrestricted airflow 270° around the sampler. 4. No furnace or incineration flues should be nearby. 5. Must have minimum spacing from roads. This varies with height of monitor and spatial scale.
SO_2	All	3-15	1	1	1. Should be >20 meters from trees. 2. Distance from inlet probe to obstacle must be at least twice the height the obstacle protrudes above the inlet probe. 3. Must have unrestricted airflow 270° around the inlet probe, or 180° if probe is on the side of a building. 4. No furnace or incineration flues should be nearby.
CO	Micro	$3 \pm 1/2$	1	1	1. Must be >10 meters from intersection and should be at a midblock location. 2. Must be 2-10 meters from edge of nearest traffic lane. 3. Must have unrestricted airflow 180° around the inlet probe.

CO	Middle and Neighborhood	3-15	1	1	1. Must have unrestricted airflow 270° around the inlet probe, or 180° if probe is on the side of a building. 2. Spacing from roads varies with traffic.
O_3	All	3-15	1	1	1. Should be >20 meters from trees. 2. Distance from inlet probe to obstacle must be at least twice the height the obstacle protrudes above the inlet probe. 3. Must have unrestricted airflow 270° around the inlet probe, or 180° if probe is on the side of a building. 4. Spacing from roads varies with traffic.
NO_2	All	3-15	1	1	1. Should be >20 meters from trees. 2. Distance from inlet probe to obstacle must be at least twice the height the obstacle protrudes above the inlet probe. 3. Must have unrestricted airflow 270° around the inlet probe, or 180° if probe is on the side of a building. 4. Spacing from roads varies with traffic.
Pb	Micro	3-15		>2	1. Should be >20 meters from trees. 2. Distance from sampler to obstacle, such as buildings, must be at least twice the height the obstacle protrudes above the sampler. 3. Must have unrestricted airflow 270° around the sampler. 4. No furnace or incineration flues should be nearby. 5. Must be 5 to 15 meters from major roadway.

Middle Neighborhood, Urban and regional	2-15	>2	1. Should be >20 meters from trees. 2. Distance from sampler to obstacle, such as buildings, must be at least twice the height the obstacle protrudes above the sampler. 3. Must have unrestricted airflow 270° around the sampler. 4. No furnace or incineration flues should be nearby. 5. Spacing from roads varies with traffic.

Separation distance between roadways and stations, meters

Roadway average daily traffic vehicles per day	Micro scale	Middle scale	Neighborhood Urban Regional scale
<10,000	5-15	>15-50	>50
20,000	5-15	>15-75	>75
>40,000	5-15	>15-100	>100

TABLE 38

STATE OF MONTANA, AIR QUALITY BUREAU
AIR MONITORING NETWORK

Station		SAROAD Site I.D.	Monitoring Objectives	Spatial Scale	Target Date: New station to open	Target Date: Existing station to close
I. Total Suspended Particulates (TSP)						
A. National Air Monitoring Stations (NAMS)						
Billings	Taft School	27 0080 062 F01	H,P,S,	N		
	Taft School (co-located)	27 0080 062 F07	H,P,S	N		
Great Falls	Downtown	27 0660 017 G01	H,P	N		1/84
	Downtown (co-located)	27 0660 017 G07	H,P	N		1/84
	Fire Station	27 0660 009 G01	H,P	N	1/84	
B. State and Local Air Monitoring stations (SLAMS)						
Anaconda	Lincoln School	27 0020 007 F01	P	N		
Billings	Sandstone School	27 0080 067 G01	P	N		
	City Hall	27 0080 008 G01	H,P	N		
	City Hall (co-1)	27 0080 028 G07	H,P	N		
	Grand Ave. Sch.	27 0080 009 G01	P	N		
	Lockwood School	27 0080 006 F05	P,S	N		9/83
Bozeman	East Main City Building	27 0120 002 F01	H,P	N		
	Whittier School	27 0120 005 F01	H,P	N		
Butte	Greeley School	27 0160 005 F01	H,P,S	N		
	Greeley School (co-located)	27 0160 005 F07	H,P,S	N		

C. Special Purpose Monitors (SPM)

Deer Lodge	Downtown		P	N	10/83	
Dillon	Downtown		P	N	10/83	
Eureka	Downtown		P	N	7/84	
Glacier N.P.	St. Marys	27 0570 010 F02	B	R		
	W. Glacier	27 0570 007 F02	B	R		
Glendive	Medical Arts Ctr.	27 0600 002 F01	P	N		
Great Falls	Franklin School	27 0660 022 G01	P	N		2/84
	Westside		P	N	2/84	
Hamilton	Courthouse	27 1300 001 F01	P	N		
Kalispell	Courthouse	27 0800 017 F01	P	N		
Laurel	Junior High	27 0840 001 G02	S,P	N		
Libby	Downtown		H,P	N	10/84	
Malta	Bowdoin Wildlife Refuge	27 1200 001 N05	B	R		
Missoula	Hoerner-Waldorf #1	27 1100 015 G02	S	N		
	Hoerner-Waldorf #1 collocated	27 1100 015 G07	S	N		
	Hoerner-Waldorf #2	27 1100 016 G02	S	N		
	Northside	27 1100 025 G01	P	N		10/83
	Boyd Park	27 1100 024 G02	P	N		
	Rattlesnake		H,P	N	10/83	
	East Missoula		P	N	10/83	
	Lolo	27 1100 026 G01	P	N		10/83

	Meadow Hill School		P	N	11/83	
	Target Range		P	N	11/83	
	Patti Canyon		P	N	11/83	
Montana City	School	27 0760 905 F05	P	N		
Plevna	Bohle Ranch	27 0440 001 N05	B	R		
Polebridge	Ranger Station	27 0480 035 F05	B	U		
Sidney	Downtown	27 1320 010 F01	P	N		
Scobey	Border Station	27 0340 001 F03	S,B	R		10/84
	Richardson	27 0340 002 F03	B	R		10/84
	Hanrahan	27 0340 004 F03	B	R		10/84
Superior	Downtown		H,P	N	6/84	
Thompson Falls	Courthouse	27 1400 003 F05	H,P	N		
Troy	ASARCo Tailings Pond		S	N	10/83	

II. LEAD (Pb)

A. State and Local Air Monitoring Stations (SLAMS)

Anaconda	Lincoln School		H,S,P	Mi	
East Helena	Hadfield	27 0860 719 F02	H,S,P	Mi	
	(co-located)	27 0860 719 F07	H,S,P	Mi	
	Hastie	27 0860 002 F02	H,S,P	M	
	Dartman	27 0860 722 F02	H,S	N	
	South	27 0860 716 F02	S	N	
	Firehall	27 0860 714 F02	H,S,P	Mi	

B. Special Purpose Monitors (SPM)

Montana City	School	27 0760 905 F05	P	N	

III. SULFUR DIOXIDE (SO_2)

A. National Air Monitoring Stations (NAMS)

Billings	Taft School	27 0080 062 F01	S,P	N		1/84
	Lockwood Park	27 0080 065 F05	S,P	N	1/84	

B. State and Local Air Monitoring stations (SLAMS)

Billings	Coburn Road	27 0080 066 F05	S	N		
	Lockwood Park	27 0080 065 F05	S,P	N		1/84

C. Special Purpose Monitors (SPM)

Billings	No. Johnson Lane	27 0080 064 F05	S	N		
	Southeast Ridge		S	N	11/84	
Colstrip			S	N	10/84	
Great Falls	Black Eagle		S	N	10/84	
Laurel			S	N	10/84	
Scobey	Border Sta.	27 0340 001 F03	S	R	10/84	
	Hanrahan	27 0340 004 F03	S	R	10/84	
Sidney			S	N	9/83	

Columbia Falls						
	Anders Residence	27 0270 005 F01	H,P	N		
East Helena	Hastie Residence	27 0860 002 F02	H,P,S	N		
	Hadfield	27 0860 719 F02	H,P,S	N		
	Hadfield (colocated)	27 0860 719 F07	H,P,S	N		
	South	27 0860 716 F02	S	N		
	Dartman	27 0860 722 F02	H,S	N		
	Firehall	27 0860 714 F02	H,P,S	N		
Great Falls	Black Eagle P.O.	27 0660 019 G01	H,P,S	N		
	Fire Station	27 0660 009 G01	H,P	N		1/84
	Downtown	27 0660 017 G01	H,P	N	1/84	
	Downtown (coloc)	27 0660 017 G07	H,P	N	1/84	
Helena	Cogswell Bldg.	27 0720 001 F01	P	N		
	Capital Courts	27 0720 013 G05	P	N		
	Cooney Home	27 0720 016 G05	P	N		
Kalispell	Universal Ath.	27 0800 015 F01	P	N		
Libby	Brown Residence	27 0900 010 F01	P,S	N		
Jordan	Billings Ranch	27 0540 02 F03	B	R		
Missoula	Courthouse Roof	27 1100 001 G01	H,P	N		
	Courthouse Roof (co-located)	27 1100 001 G07	H,P	N		9/83
	Rose Park	27 1100 020 G01	P	N		
	Rose Park (colocated)	27 1100 020 G07				
Ovando	Terry Smith Ranch	27 1260 024 F03	B	R		

IV. CARBON MONOXIDE (CO)

A. State and local Air Monitoring stations (SLAMS)

Billings	Fairgrounds	27 0080 061 F02	H,P,S	M		
Great Falls	Gt. Falls Fed.	27 0660 021 G02	H,P,S	M		10/83
Great Falls	New 10th Ave. South		H,P,S	M	10/83	

B. Special Purpose Monitors (SPM)

Missoula	Boyd Park	27 1100 024 G02	P	N		
Libby	Downtown		H,P	M	11/83	

V. OZONE (O_3)

A. Special Purpose Monitors (SPM)

Billings	East Northeast		S	P	10/84

VI. NITROGEN DIOXIDE (NO_2)

A. Special Purpose Monitors (SPM)

Billings	East Northeast		H	U	10/84

Monitoring Objectives:

H Highest Concentration
P Population
S source
B Background

Spatial Scales:

Mi Micro
M Middle
N Neighborhood
U Urban
R Regional

TABLE 39

MONTANA AND NATIONAL AMBIENT AIR QUALITY STANDARDS

Polltant	Montana standard	Federal Primary Standard	Federal Secondary Standard
Total Suspended Particulates	75 ug/m^3 annual average 200 ug/m^3 24-hr average*	75 ug/m^3 annual geometric mean 260 ug/m^3 24-hr average*	60 ug/m^3 annual geometric mean 150 ug/m^3 24-hr average*
Sulfur Dioxide	0.02 ppm annual average 0.10 ppm 24-hr average* 0.50 ppm 1-hour average**	0.03 ppm annual average 0.14 ppm 24-hr average*	0.5 ppm 3-hr average*
Carbon Monoxide	9 ppm 8-hr average* 23 ppm hourly average*	9 ppm 8-hr average* 35 ppm 1-hr average*	9 ppm 8-hr average*
Nitrogen Dioxide	0.05 ppm annual average 0.30 ppm 1-hr average*	0.05 ppm annual average	0.05 ppm annual average
Photochemical Oxidants (ozone)	0.10 hourly average*	0.12 ppm 1- hr average*	0.12 ppm 1-hr average*
Lead	1.5 ug/m^3 90-day average	1.5 ug/m^3 calendar quarter average	0.12 ppm 1-hr average*
Foliar Fluoride	50 ug/g monthly average*** 35 ug/g grazing season average	None	None
Hydrogen Sulfide	0.05 ppm hourly average*	None	None
Settled Particulate (Dustfall)	10 gm/m^2 30-day average	None	None
Visibility	Particle scattering co-efficient of 3 x 10^{-5} per meter annual average	None	None

*Not to be exceeded more than once per year
ug/m^3 micrograms pollutant per cubic meter of sampled air
ppm parts pollutant per million parts of sampled air

**Not to be exceeded more than 18 times per year.

***April through September only

TABLE 40

RELATIONSHIP BETWEEN SITING OBJECTIVES AND DATA USES

General Monitoring Objectives	Specific Monitoring Objectives	Data Uses
A. Highest Concentration	1. Determination of Peak Concentrations in urban and Nonurban areas	Judging attainment/maintenance of NAAQS Evaluating progress in achieving/maintaining of NAAQS Developing/revising SIPS/evaluating control strategies. Supporting enforcement action. Public Information.
	2. Emergency Episode Abatement Initiation and Monitoring.	Documenting episodes and initiating episode controls. Public information.
B. Population	1. Determination of Population Exposure in Populated Areas	Documenting population exposure and health research. Public Information.
C. Source Imapct	1. Determination of the impact of isolated point sources	Developing/revising SIPs/evaluating strategies. Reviewing new sources. Supporting enforcement actions.
	2. Determination of the Impact of Individual Point Source in Multi-Source Urban Setting.	Developing/revising SIPs/evaluating contr strategies. Reviewing new sources Supporting enforcement actions.

D. General Background	1. Determination of Base Concentration in Areas of Projected Growth.	Establishing baseline air quality levels for PSD planning and AQMP. Evaluating progress in achieving/maintaining NAAQS. Developing/revising SIPs to attain/maintain NAAQS. Public Information
	2. Assessment of Background Concentration in Rural Areas.	Establishing baseline air quality levels for PSD planning and AQMP. Developing/revising SIPs to attain/maintain NAAQS Public Information
	3. Diffusion Model Calibration and Refinement.	Estimation of air quality levels.

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